Air Force Manufacturing Technology

DISTRIBUTION STATEMENT A
Approved for Public Release
Distribution Unlimited

Year 2000 Project Book

A Digest of the Air Force's ManTech Activities

APPROVED FOR PUBLIC RELEASE

The Manufacturing Technology (ManTech) Project Book is designed to provide information on significant accomplishments and to expedite direct exchanges between government and industry management concerned with broadbased ManTech activities. Recipients are encouraged to route the publication to associates and other organizational functions engaged in manufacturing related program activities. All comments relating to this supplement should be directed to AFRL/MLOP, Bldg 653, 2977 P Street, Suite 13, Wright Patterson AFB, OH 45433-7739. Telephone: (937) 255-4689. Approved for public release.

FOREIGN DISSEMINATION

Details regarding many specific ManTech programs are subject to special export controls. Therefore, follow-up from any foreign sources should be processed through embassy channels following normal procedures for request of technical information or technology transfer.

Contents

Advanced Industrial Practices

Electronics

Manufacturing and Engineering Systems

Metals

Nonmetals

Materials Process Design

Title III

Advanced Modular Factory Program

Contract Number: F33615-96-2-5113 **ALOG Number: 1488**

Statement of Need

Adaptation and implementation of best industrial practices is a centerpiece of the transformation of the defense industrial base. The adoption of lean production principles, as characterized first by the Japanese automotive industry, is showing immense benefits for previously inflexible, nearly-captive military producers in the U.S. industrial complex. This lean implementation program focused on the demonstration of a particular factory operational concept popularized in a few commercial production enterprises. Those commercial producers have seen vastly improved flexibility and quality coupled with reduced costs and cycle time; similar benefits for the production of defense product were therefore the objective of this program, as was a collection of a cogent business case for the changes wrought.

Approach

Raytheon Missile Systems (RMS) used as a baseline the current missile business practices and manufacturing processes in use at their Tucson, Arizona facility. RMS developed, implemented, validated, and measured alternative business practices as well as new manufacturing processes identified by the Lean Aircraft Initiative (LAI). A transferable methodology was developed for evolving military-unique operations into common lean business practices and manufacturing processes. Validated lean practices and processes were transferred into a demonstration missile product line and the before-and-after performance was measured along with well defined metrics. The process methodology was documented so that the experience and lessons learned could be transferred to other product lines and aerospace companies.

Benefits

Raytheon Missile Systems applied modular factory concepts to the flow of materials through its missile factory in Tucson. RMS demonstrated how to reduce order fulfillment time on the AMRAAM by 40 percent while eliminating critical path waste, reducing internal cycle times by 50 percent, reducing inventory across the plant by 40 percent, and doubling inventory turns plant-wide.

Status

Complete
Start date: March 1996
End date: August 1999

Resources

Project Engineer:
Brench Boden
AFRL/MLMS
(937) 904-4399

Contractor:
Raytheon Company

JDMTP Subpanel:
Advanced Manufacturing Enterprise

Agile Infrastructure for Manufacturing Systems Pilot

Cooperative Agreement Number: F33615-95-2-5520 ALOG Number: 1349

Statement of Need

Agility in manufacturing is viewed as the ability to thrive in an environment of continuous and often unanticipated change through an enterprise geared toward "reconfigurable everything." Agility addresses the business enterprise world, including: business practices; the culture of management and employees; financial control and operations; relationships of the customer, assembler, and supplier; manufacturing process integration with design information systems to support decision making information systems for empowering workers; accounting systems to reflect operations; and education and training. This initiative included the "lean manufacturing" emphasis on the streamlined, efficient use of resources and the minimization of waste. It also embraced the best commercial quality management practices of customer focus, an empowered and knowledgeable workforce, teamwork, communication, and continuous improvement. It also included integrated product/ process development and flexible manufacturing capabilities; required flexible management structures with commitment to societal and environmental concerns; and required a networked infrastructure capable of supporting "virtual corporations" and other agile organizations that can respond to rapidly changing market demands.

Approach

This program demonstrated and evaluated the advanced design, manufacturing, and business transaction processes that enable agility within an organization. The program focused on the technical and cultural tools necessary to bring agile manufacturing to the aerospace industry. The Agile Infrastructure for Manufacturing Systems (AIMS) Net Server was upgraded with the latest release of the commercial version of AIMSNET. Supplier Data Requirements, End Item Data Packages, and technical information is being provided through AIMSNET instead of in hard copy. The program provided: a working virtual corporation prototype; a proven, scalable support architecture; a template for agile business transactions over the Internet; procedures and metrics for certifying and categorizing agile suppliers; validated metrics for managing an agile virtual corporation; and a migration business plan for the resulting products.

Benefits

This program will enable companies with different, complementary core capabilities to come together as virtual corporations and will remove roadblocks that hinder rapid and efficient teaming arrangements in an electronic commerce environment. AIMSNET provides savings in cycle time and costs and increases the availability of the information from any site.

Status

Complete
Start date: January 1995
End date: August 1999

Resources

Project Engineer:
Daniel Lewallen
AFRL/MLMS
(937) 904-4343

DARPA Funded

Contractor:
Lockheed Martin Corporation

JDMTP Subpanel:
Advanced Manufacturing Enterprise

Air Armament Decision Support System (AADSS)

Contract Number: F33615-96-D-5101/033 **ALOG Number: 2608**

Statement of Need

Air Combat Command (ACC) requires quicker and more thorough insight into their Operational Flight Program (OFP) in order to enhance their command decision making process. ACC needs an advanced tracking system with predictive capability to provide insight into selected program and system status, as well as specific asset availability. ACC desires the seamless and non-intrusive attributes of AADSS for the purpose of monitoring critical USAF aircraft assets through the block software upgrade process.

Approach

AADSS is an advanced prototype command and control system which identifies and tracks critical items and activities, providing a real-time status update. The approach is to explore and demonstrate AADSS for application to a subset of real-time/network-based information. This effort is designed to demonstrate and assist in the implementation of a decision support system utilizing Lean Aerospace Initiative (LAI) concepts allowing for identification, tracking, status updates, and predictions. On-Line Analytical Processing (OLAP) will be investigated for the efficient transfer of information from remote data sets. The system will be integrated at a selected System Program Office (SPO) location in order to demonstrate the ability to eliminate unforeseen schedule delays and slippage. The demonstration will use existing databases and be non-intrusive to the conduct of on-going SPO efforts.

Benefits

Item and activity status will provide weapon planners with greater insight into the availability of critical aircraft, allowing for greater efficiency in the scheduling of these much-needed assets. The end result will be a measured increase in the number of operationally available aircraft, thus enhancing the overall force structure through efficient and effective system upgrades. AADSS in this application will fill information voids, provide flag level visibility of programs of interest, provide cost reduction through better, more informed, decision making and improve scheduling efficiency. This work, demonstrating and assisting in the implementation of an advanced tracking system as it relates to the Operational Flight Program process, will pave the way to demonstrate and assist in the implementation of a command and control system to identify the readiness of munitions in terms of quantity, location, and stock availability.

Status

Active
Start date: May 1999
End date: February 2000

Resources

Project Engineer:
Michael Baker
AFRL/MLMA
(850) 882-6982 ext. 6076

Air Force Funded

Contractor:
Decision Sciences Incorporated

JDMTP Subpanel:
Advanced Manufacturing Enterprise

Critical Supply Chain Analysis (CSCA)

Contract Number: F33615-96-D-5101/008 **ALOG Number: 2609**

AIP Advanced Industrial Practices

Statement of Need

Fifty to seventy percent of the cost of a system can be traced to the costs directly associated with the suppliers of systems components. Many of the productivity and manufacturing capability programs initiated between the DoD and its prime contractors, such as the Lean Aerospace Initiative (LAI), rarely flow down to lower tier suppliers. As a result, risks to program costs and schedules due to problems in the supply base (obsolescence, financial viability, lead times) have increased as the aerospace industry as a whole has consolidated. Deployment is needed to improve visibility into complex items manufactured by critical suppliers in program development enhancing the migration of DoD sponsored technology and business processes from their prime contractors.

Approach

The approach is to demonstrate total value chain visibility on three critical suppliers of an Air or Space Force Applications program and their related industrial base concerns. The process will provide prime contractors the source of the information needed for understanding and evaluating the total flow process, which would advance improvements in quality, reliability, and collaborative design. Expected end item(s) are:

1. Integration which maximizes off-the-shelf products, to provide for seamless and near real-time exchange of communication, tracking information of value chain vendors, simulation capability of the probable results of changes, improvements, quantity variations, and other "What-If" options to the capability of industry for lean manufacturing.

2. Training tailored for the specific System Program Office focused on leveraging lean practices with a high probability of success would provide measurable cost and/or schedule improvements.

Benefits

By improving the level of visibility between the critical suppliers and their industrial base there will be:

- Decreases in overall cycle time when integrating supplier schedules with program milestones
- Reductions in delinquent deliveries to the prime contractor.
- A 5 percent to 10 percent reduction in costs

Status

Active
Start date: November 1999
End date: September 2000

Resources

Project Engineer:
Michael Baker
AFRL/MLMA
(850) 882-6982 ext. 6076

Contractor:
Decision Sciences Incorporated

JDMTP Subpanel:
Advanced Manufacturing Enterprise

Labor Infrastructure for Agile High Performance Transformations

Contract Number: F33615-95-C-5512 **ALOG Number: 1366**

Statement of Need

In recent years while high performance and agile workplace innovations have become critical to maintaining jobs and living standards, America's industrial unions have had only a limited ability to invest in developing new internal capacity for promoting those needed changes. In an era of defense and manufacturing downsizing, union membership loss, and subsequent cutbacks in union budgets, manufacturing unions have had difficulty investing in new staff specialists, programs, policies and supportive materials to develop a proactive union agenda for achieving agile high performance (AHP). As a result, the rates of success in implementing AHP production systems in union-represented facilities have been lower than they should have been. To support agile and high performance work systems, union programs and materials are needed for promoting new labor goals including greater investments in continuous skill acquisition; greater empowerment of the production workforce in concurrent design; direct production worker contact with customers and suppliers; shopfloor identification of new technologies, markets, and products; and strategic planning to assure viable employment security for the workforce.

Approach

The approach used developed a case study methodology involving three teams. Case studies were conducted of networks, model for growing networks and maintaining mature networks, complimentary network material to go with the NIE material, metrics for network effectiveness, replication model development, and creation and refinement of network. Case studies and histories were prepared on two best practice companies and three target companies, establishment of metrics, customization of handbooks, AHP skills training, collection of metrics, and assessment, review, and revision of transformation plan.

Benefits

The program was successfull in addressing the issues customers and suppliers face in evaluating supply chain effectiveness. Assessment booklets were developed which address key issues within an enterprise. The project developed an innovation-fostering program of workplace change initiatives in which unions play a proactive role in design and implementation, rapidly accelerated the process of upgrading workplace efficiency, flexibility, and agility.

Status

Complete
Start date: February 1995
End date: July 1999

Resources

Project Engineer:
Capt. Paul Bentley
AFRL/MLMS
(937) 904-4355

DARPA Funded

Contractor:
Work & Technology Institute

JDMTP Subpanel:
Advanced Manufacturing Enterprise

Lean Aerospace Initiative

Cooperative Agreement Number: F33615-93-2-4316 ALOG Number: 1137

Statement of Need

Lean concepts present the U.S. military aircraft industry with an opportunity to address the challenges presented by both reductions in DoD procurements and worldwide competition. The adoption of lean principles and practices will allow the industry to meet customer requirements for affordability without sacrificing performance. Through this effort the industry's position as the world's leading producer of advanced technology aircraft systems will be strengthened.

The Lean Aerospace Initiative (LAI) had its genesis in the five-year International Motor Vehicle Program conducted by a Massachusetts Institute of Technology (MIT) research team as described in the book, "The Machine that Changed the World." The LAI was funded through a cooperative agreement between the government and MIT. Using separate contracting vehicles with MIT, the aerospace industry provided MIT's share of the cooperative agreement with funding from each of the 18 member companies.

The objective of the LAI was to develop a framework for implementation of a fundamentally different, provable better way of manufacturing, enterprise-wide, that would better support the defense aircraft needs over the next 30 years.

Approach

Phase I of the LAI concluded in September 1996. It established an Executive Board comprised of senior industry, organized labor, and government personnel to assist in steering the effort. Three Lean Forums were conducted in Phase I to transition research findings to the customer base and establish requirements for both technology and acquisition investment planning processes. Based upon MIT LAI research findings, seven advanced manufacturing demonstration projects which pilot the feasibility of lean practices were funded. Industry members are taking LAI findings and applying lean practices within their companies, as evidenced during government/industry information exchanges. LAI Phase II modified the cooperative agreement by extending the period of performance three years and expanding the scope of government and industry participation. The primary means of documenting LAI research findings is through the Lean Enterprise Model (LEM). Research results are organized to populate the LEM with data on lean practices, metrics, benchmarking information, interactions, key benefits, major barriers, and mitigation strategies. Phase II continues with many aspects of the existing program (research focuses on domestic military aircraft industry, collaborative participation) and incorporates changes based on lessons learned (e.g., optimize oversight process). The LAI Phase II worked towards a vision of significantly cutting the cost and cycle time for military aircraft while continuing to improve product performance.

Benefits

"Lean" is a fundamentally different approach to managing and organizing the enterprise. Most member companies have formulated a program with goals which embrace Lean principles and practices, with primary emphasis on production operations with upstream links to design. Primary Lean targets in government have been the reduction of cycle time for procurement actions and development of seamless information systems. LAI is providing a focus and framework for understanding and adopting Lean.

Status

Complete
Start date: September 1993
End date: September 1999

Resources

Project Engineer:
John Klempay
AFRL/MLMA
(937) 255-3701, ext 246

Air Force Funded

Contractor:
Massachusetts Institute of Technology

JDMTP Subpanel:
Advanced Manufacturing Enterprise

AIP Advanced Industrial Practices

Lean Suppliers Integration Demonstration (LSID)

Contract Number: F33615-96-D-5101/037 **ALOG Number: 1623**

Statement of Need

The requirement was to demonstrate the precepts of lean thinking and associated value from supplier activity. At Lean Aerospace Initiative (LAI) Lean Forum V, LSID was part of the Space Sector's top priority topic presentation for deployment of LAI concepts to the supplier chain. Approximately seventy percent of the cost of a system can be traced to the costs directly associated with the chain of suppliers of system components and this concept is known as the "value chain" in lean thinking. Capability, quality, and cost are not just results of design alone but are derived from the ability to transfer design into hardware that is capable of performing to expectations. LSID demonstrated such ability to assist in the enabling advancements in lean manufacturing, paramount to the future of manufacturing.

Approach

LSID has thus far successfully completed an actual hardware/ software demonstration on-site in a supplier and vendor plant using both the internet and intranet. There were two primary thrusts within the Lean Supplier Integration Demonstration concept. The first is the Real-Time Tracking and Information System, and the second is the Presentation and Simulation System. LSID advanced On-Line Analytical Processing (OLAP) to provide the seamless transfer of information from the supplier to a prime database repository. The prime database repository thus becomes the common database of information. OLAP transfers information needed for presenting and simulating the total flow process of a network of subcontractors supplying components to a prime manufacturer. LSID provides for the status of information, choke-point analysis, and quality representation of data collection; in addition to an overall status of manufacturing progress, production analysis from the current period to end of contract, excess parts accumulation, shift and capacity analysis, and other important factors of the overall production network. As an enterprise model, LSID incorporates SQL database technology and is fully capable of proceeding to demonstrate multiple user capability.

Benefits

An end-to-end demonstration of the use of existing leading edge OLAP technology, simulation capability, tracking capability, and seamless data interchange for improvement of value chain manufacturing, LSID experientially integrates LAI concepts. LSID demonstrates total value chain visibility, provides for near real-time communication, tracks information of critical value chain vendors; and exploits its extensive simulation capability to improve understanding of the probable results of changes (such as hardware/software modifications, schedule changes or quantity variations, and other "What-If" options) to optimize LAI deployment to manufacturing in industry.

Status

Complete
Start date: November 1998
End date: September 1999

Resources

Program Manager:
Michael Baker
AFRL/MLMA
(850) 882-6982 ext. 6076

Air Force Funded

Contractor: Decision Sciences Incorporated

JDMTP Subpanel:
Advanced Manufacturing Enterprise

Lean Sustainment Initiative

Contract Number: F33615-96-D-5101 **ALOG Number: 1284**

Statement of Need

This program builds off the Sustainment 2005 Organic Industrial Base assessment which examined areas within the depot maintenance structure requiring fundamental change, either through technology insertion or adoption of supportive business policies and practices. The aging force structure and diminishing budget have elevated the importance of the sustainment mission. An outgrowth of the Lean Aircraft Initiative, this project will make available to the Lean Logistics (LL) community the unique research experience and capability of the Massachusetts Institute of Technology (MIT) in the area of lean principles, practices, and change strategies. This program is expected to stimulate fundamental change within the entire sustainment enterprise and will emphasize depot maintenance (contract and organic).

Approach

The Lean Sustainment Initiative will distill and disseminate existing MIT lean principles and change management knowledge to Air Force, DLA and industry personnel. Research of world class lean repair commercial organizations will be conducted and critical lean principle and change management lessons learned will be communicated to the sustainment community.

Benefits

This program will help identify "best practices" that should be considered for adoption within the Sustainment Industrial Base, enabling it to eliminate waste and achieve a lean enterprise posture. This will assist the Air Force in providing agile combat support to the warfighter.

Status

Active
Start date: April 1997
End date: December 2002

Resources

Project Engineer:
Trixie Brewer
AFRL/MLMP
(937) 904-4370

Air Force Funded

Contractor:
GRC International,
Massachusetts Institute of Technology

JDMTP Subpanel:
Advanced Manufacturing Enterprise

Lean Transition of Emerging Industrial Capability (LeanTEC)

Cooperative Agreement Number: F33615-97-2-5153 ALOG Number: 1679

Statement of Need

The objective is to apply Lean practices and principles to identify new methods which enable timely and affordable insertion of advanced technology into weapon systems. This program targets those process improvements within a manufacturing enterprise that enhance the transfer of advanced technology from the development laboratory to manufacturing with attendant benefits in product performance and quality and with reduced cost and development-to-implementation cycle time.

Approach

The approach is to: a) select candidate technologies to assess technology transition process; b) identify technology transition barriers and new methodologies/strategies for dealing with barriers; c) study suitable benchmarks; d) structure a model of the "As-Is" technology transition process; e) structure a model of the "To-Be" technology transition process; f) formulate experiments to validate improvements and benchmarks in the "To-Be" model; g) conduct experiments and quantify the results in terms of improved technology transition into Air Force aircraft; and h) disseminate results to the LAI community.

Benefits

Improved processes, procedures and practices for the implementation of advanced technology into Air Force weapon systems, providing potential for saving millions of dollars on future advanced technology transition and insertion.

Status

Active
Start date: December 1997
End date: August 2001

Resources

Project Engineer:
Laura Leising
AFRL/MLMP
(937) 904-4388

Air Force Funded

Contractor:
Boeing Company

JDMTP Subpanel:
Advanced Manufacturing Enterprise

Lean Value Chain for Critical Part Procurement

Contract Number: F33615-98-C-5168 **ALOG Number: 2564**

Statement of Need

Lean Technologies have proven to produce significant reductions in production cycle time, inventory levels, overhead expenditures, etc. The members of the Lean Aircraft Initiative submitted the concept that these process improvements could make dramatic improvements in the Depot Maintenance, Repair and Overhaul (MRO) Operations. The Lean Value Chain for Critical Part Procurement was released as a Broad Area Announcement to address the cycle time responsiveness of the MRO Operations for critical parts -- those parts that are required to return a weapon system to the operational inventory -- by using proven Lean Technologies. The nature of critical parts motivates the MRO community to reduce the cycle time to produce them down to the absolute minimum. The developers of this project have determined that a 50 percent reduction in critical part procurement process cycle time using Lean Technologies is a realizable initial target.

Approach

The Lean Value Chain for Critical Part Procurement Program will develop and demonstrate tools and technologies to promote the rapid acquisition of critical spare parts in support of system management of propulsion systems. The tools and technologies will be sufficiently extendible and robust to support all types of component part acquisition conducted with the defense industrial base. The concept of critical parts is a concern all across the DoD Logistics Operations. In most depot operations there are four types of shops that experience critical part problems. The Programmed Depot Maintenance (PDM) Lines where the weapon systems are inspected, disassembled, repaired (or pieces routed for repair), re-assembled, tested, and sold. The Front Shops where subsystems are inspected, disassembled, pieces routed for repair, re-assembled, and tested also have critical parts. Back Shops perform a similar workload as the Front Shops with the addition of performing large amounts of repair in the shop. Items routed from the Back Shops typically end up in Bucket Shops or Process Shops. Bucket Shops do little or no further routing, and they inspect, disassemble, repair or scrap, re-assemble, and test. Key to this approach is to establish a fielding, demonstration, and evaluation effort in a PDM Line, Front Shop area and a Back Shop area in order to get a broad understanding of the Critical Part (CP) problem. The detailed analysis of the Critical Part Processes mentioned above will create the foundation for a cyclic approach (using three cycles) that will field, demonstrate, and evaluate appropriate Lean Technologies in Current MRO Operations located on Oklahoma Air Logistics Center and the Corpus Christi Army Depot. Each implementation area will have its own set of product flows and will influence the interaction of those flows and the integration between the solutions with associated product flows. The broad implications of the implemented Lean Technologies will be carefully tracked to ensure that no local optimization is being implemented at the expense of overall MRO responsiveness.

Benefits

Cost reductions will result in the reduced time from shop floor awaiting parts though part procurement to part supply back to requester. As an example, in engine repair cycle, 50 percent of cycle time attributed to AWP. Shorter periods in depot directly correlate to a reduced number of DoD spares needed.

Status

Active
Start date: April 1999
End date: April 2002

Resources

Project Engineer:
John Barnes
AFRL/MLMP
(937) 904-4391

Contractor:
Knowledge Based Systems Incorporated

JDMTP Subpanel:
Advanced Manufacturing Enterprise

Military Products Using Best Commercial/Military Practices

Contract Number: F33615-93-C-4334 **ALOG Number: 1255**

Statement of Need

Incorporating the best commercial practices into defense production facilities and expanding the potential for dual-use factories ultimately means more affordable weapon systems. The objectives of this pilot were to successfully demonstrate the ability to build a more affordable, lighter weight C-17 horizontal stabilizer in an integrated factory using best commercial/military practices, and to achieve equal or better quality levels, reduced weight, and a decrease in cost when compared to the existing business and performance baseline. This program has been strongly endorsed by the C-17 System Program Office (SPO). Data collected throughout the program was used by the C-17 SPO to determine if cost benefits are sufficient to warrant incorporation of revised business practices and the improved stabilizer into their program. Transition of business policies and practices, manufacturing infrastructure, and process technology improvements to the C-17 SPO and the aerospace community is a key measure of the pilot success.

Approach

The pilot contract was structured in two consecutive phases. The Development Phase, focused on selecting and prototyping the best business policies and practices, manufacturing infrastructure, and process technology improvements to be demonstrated in Phase II. The Demonstration/Validation Phase, of the pilot effort finalized the design, and fabricated a full-scale improved C-17 stabilizer using the business policies and practices and manufacturing infrastructure improvements from Phase I, while measuring improvements from the business policies and practices, manufacturing infrastructure, and process technology changes. A structural certification test of the stabilizer was conducted at the conclusion of Phase II.

Benefits

The new stabilizer is 20 percent (500 pounds) lighter and is slated to be installed in shipset P51. It has 2,000 fewer parts, 42,000 fewer fasteners, and requires 1,000 fewer tools. It saved more than $2 million in development by incorporating electronic design tools, modeling and virtual reality and eliminating engineering mock ups.

Status

Complete
Start date: June 1994
End date: December 1998

Resources

Project Engineer:
Dr. Frances Abrams
AFRL/MLMP
(937) 904-4380

Air Force Funded

Contractor:
McDonnell Douglas Corp.

JDMTP Subpanel:
Advanced Manufacturing Enterprise

Modular Factory for Electronic Warfare Component Manufacturing

Cooperative Agreement Number: F33615-95-2-5564 ALOG Number: 1264

Statement of Need

The Lean Aircraft Initiative (LAI) has identified flow optimization as an enabling practice for the production enterprise. Benchmarking data from the LAI suggests that a modular organization of the factory is a powerful means of optimizing flow. Derivation and demonstration of the modular factory concept for the defense production environment requires consideration of business practice changes, infrastructure improvements, and identification of the barriers and disincentives to its implementation. This lean implementation effort focuses on demonstration of the modular factory concept against electronic warfare component manufacture, demonstrating emphasis on up-front assessment of cost drivers and affordability concerns. The Microwave Power Module (MPM) is an enabling technology for the 21st century. MPMs are complete microwave amplifiers of unprecedented miniaturization. Unsurpassed performance in terms of broadband power and efficiency has been demonstrated but the major challenge prohibiting large scale insertion at this time is cost. Furthermore, defense acquisition focus has changed from performance at any cost to affordability, placing additional pressure on the industrial base. For a defense producer to meet the challenge of reduced cost while attracting a commercial business base, a flexible or modular approach to production is warranted. The objective of this program was to demonstrate a modular factory approach to the manufacture of defense products. The program organized a production enterprise into major subassembly elements with technical and business measures for greater efficiency, less waste, lower cost, and greater flexibility. Defense manufacturing is currently accomplished under mass production management methods and procedures, which are inherently inflexible and inefficient for short production runs. The Lean Aircraft Initiative, an industry-government-academia consortium led by the Massachusetts Institute of Technology, is assessing the current state of practice in the defense industry and identifying new directions for improvement.

Approach

The modular factory was a reorganization of production resources into semi-autonomous modules, each with total responsibility and authority for a set of processes, adding value to the product to ensure success for the entire enterprise. Typically, modules are arranged within the factory around the assembly sequence, with the next higher assembly operation as the customer. The module is characterized by: empowerment of workers and teams, emphasis on training for skill interchangeability, dedicated capital equipment, aggressive inventory reduction, focus on work flow velocity, shop floor density to reduce transportation time, and gain-sharing incentives for employees. Northrop Grumman Electronic and Systems Integration Division developed, through an 18 month pathfinder effort, a streamlined design-to-manufacturing link that includes an automated equipment interface with in-house design tools, a design database, and a networked data link between engineering and manufacturing. These capabilities were implemented for a pilot demonstration of a modular factory for the production of MPMs.

Benefits

This project applied the leading edge production philosophy of modular flow (as identified by the Lean Aircraft Initiative) to the production of MPMs. Expected benefits include 40 percent reduced cost, 40 percent shorter design-to-market cycle time, and higher hardware reliability. Furthermore, an affordable source of MPMs will emerge to support various new and existing systems, upgrades and modifications, and spare requirements. There is long-term potential to open commercial markets for this product class.

Status

Active
Start date: October 1995
End date: July 2000

Resources

Project Engineer:
Brench Boden
AFRL/MLMS
(937) 904-4399

Contractor:
Northrop Grumman Corporation

JDMTP Subpanel:
Advanced Manufacturing Enterprise

National Center for Manufacturing Science

Contract Number: F33615-96-C-5619 **ALOG Number: 73**

Statement of Need

Once the U.S. was the world leader in the manufacture of machine tools; now the U.S. ranks fourth behind Japan, Germany, and Russia. In just six years, the U.S. imports of iron and steel mill products have surged to eight times the exports of those same countries. Many reasons existed for the nation's increase in imports over exports, and factors originating in manufacturing were only partially responsible. The first step to rectifying the problem was to conduct the research and technology transfer in manufacturing engineering required to return U.S. companies to world-class manufacturing leaders. The National Center for Manufacturing Science (NCMS) is a nonprofit research consortium of U.S. manufacturers, organized under the 1984 National Cooperative Research Act. It was designed to fund manufacturing research projects that would meet the needs of U.S. industry, including the U.S. machine tool industry, and promote the use of new technology in U.S. manufacturing companies. A major objective of the NCMS was to provide a focus for the cooperative efforts within industry, and to establish a research agenda to address the manufacturing needs of U.S. industries in a global economy. This agenda was based on the stated needs of the member companies and was organized as a series of topical areas that encompassed individual manufacturing research and development projects. These projects were to be executed through a combination of private, state, and federal funds. In their individual R&D efforts, companies were often forced to choose between the short-term, incremental improvements they needed to stay in business, and the long-term, "breakthrough" technologies they needed to bolster their global competitiveness in the future. By offering effective leveraging of their resources, NCMS helped companies achieve both objectives. Companies were only as strong as the supplier base on which they depended. NCMS provided the "safe harbor" environment that fostered and encouraged the mutual participation of users, suppliers, and others in a collaborative process - a process that involved collective decision-making, execution, and management of technology development programs.

Approach

NCMS currently has a membership of two hundred companies which includes the Who's Who of American industry. The NCMS technical agenda is member driven and 90 percent of the technical projects are planned and performed by the membership companies. The technical projects are characterized as being pervasive collaborative efforts wherein NCMS provides 35 percent of the funding and the remaining 65 percent of the funding is provided with in-kind funds from the participating companies. There are seven Strategic Initiative Groups (SIGS) which plan and approve the NCMS technical agenda and technical projects which are performed by the Technical Advisory Groups (TAGS) made up of member companies. These seven SIGS embody the following technical areas: Electronics, Materials and Processing, Production Equipment, Management Practices, Computer Integrated Operations, Environmental Conscious Manufacturing, and Services. Within these seven SIGS, NCMS is performing approximately forty collaborative technical projects.

Benefits

The benefits of this program include the promotion of research and technology transfer in manufacturing engineering in the United States. Development of a defense-driven, industry-led collaborative technology development agenda will have both broad application across Department of Defense weapon systems, contractors, and commercial industry and their supplier tiers, and have the capability of enhancing national security and the overall competitiveness of U.S. manufacturers.

Status

Complete
Start date: April 1996
End date: April 1999

Resources

Project Engineer:
Theodore Finnessy
AFRL/MLMS
(937) 904-4344

Air Force Funded

Contractor:
National Center for Manufacturing Science

JDMTP Subpanel:
Advanced Manufacturing Enterprise

Product Research Market Analysis System

Contract Number: F33615-96-D-5101/054 **ALOG Number: 2610**

AIP Advanced Industrial Practices

Statement of Need

Today and tomorrow's industrial base presents a confluence of several technological factors that redefines traditional development planning and manufacturing methods. Fewer suppliers and constantly changing technology combine with the task to extend weapon system life expectancy. Trends towards lean manufacturing and acquisition reform require new thinking and applications for the maintenance and sustainment of weapon system capability. Replacement parts, planned weapons, and even exploratory development require affordable tools with state-of-the-art capability.

Approach

The approach is geared to produce an economic tool that will simulate the status and conditions of weapon systems as they are effected by variations in the economic and technological conditions of the acquisition environment. PReMAS must allow the study of overall technology status as simulated variations in program parameters are made. This will lead to the development of optimal strategies for planning and budgeting. PReMAS is a phased activity. Phase I encompasses the investigation and methodology for using state-of-the-art technology to provide for an automated link to potential advanced industrial practices in order to advance the capability for "front-end" planning and analysis for the future development of intelligent munitions systems. This includes the investigation of the current system architecture as well as a high level review of requirements and cost models. Phase I will culminate in the demonstration of a system construct illuminating the advantages of seamless information flow between critical munitions development tools at a high level of integration (i.e., WBS – first major indention level) on a weapons system such as the CAV. Phase II efforts will be a concentrated and systematic process of providing a further resolution for the integration of selective development tools. Phase II effort would converge on the advancement of a central interface that can be structured to function within the system architecture(s) at Eglin Air Force Base so that specific component level tools and methodologies can be accessed. Program management activities will be performed during the conduct of this effort to integrate the subsystem cost, performance, and other tools and methodologies that were previously evaluated during Phase I. The selected tools and methodologies, once evaluated for utility in conjunction with USAF sponsors, will be integrated into the central interface structure. The effort would culminate with a demonstration of an operational system that is configured to address specific WBS Level II development tools. PReMAS would aid in the development of the definition of requirements, development of acquisition strategies, the execution of price-based acquisitions and the conduct of source selections. The initial concept is to utilize a web-based architecture that would facilitate sharing of information between centers within the product line.

Benefits

The goal of this effort is to furnish the munitions planner with an operational system that will facilitate the rapid development of munitions systems. This tool will expand the use of commercial item solutions and the adoption of commercial practices in support of warfighter needs, support the use and conduct of price-based acquisition strategies including the development and deployment of training and tools, and integrate the technical, contracting and program management functions in the conduct of market research. The bottom line is for an integrated approach using lean and agile manufacturing techniques to assure affordable weapon systems refinement and subsystem replacement.

Status

Active
Start date: May 1999
End date: May 2000

Resources

Project Engineer:
Michael Baker
AFRL/MLMA
(850) 882-6982 ext. 6076

Contractor:
Decision Sciences Incorporated

JDMTP Subpanel:
Advanced Manufacturing Enterprise

Acoustic Wave Inspection of SOI Substrates

Contract Number: F33615-98-C-5111 **ALOG Number: 2288**

Statement of Need

The objective of this Phase II Small Business Innovation Research (SBIR) project is to continue to develop technology for detecting and quantifying Separation by Implanting of Oxygen (SIMOX) wafer defects and establishing correlation between ISTS and device radiation hardness and yields. Phase II technical activities are underway and approximately 40 percent complete. The goal is to understand how silicon (Si) and boron oxide (BOx) thickness affect the acoustic signals from the SIMOX substrate. The assumption is that defect density is related to Si and BOx thickness and that the Impulse 300 machine will provide a quick and accurate means of determining SIMOX defect densities. Results to date indicate: the data is real and not random; the signal to noise ratio is sufficiently high; the contour maps are repeatable.

Approach

The contractor will implement shorter wavelength laser exitation to enhance ISTS detection capability. The contractor will also investigate methods of automating multiple point testing on rad tolerent SOI substrates and the generation of statistical yield data. A minimum of five wafers per lot for 20 production lots will be examined for non-destructive and automated analysis of silicon defect density and gauge of material quality for gate oxide integrity. The fabrication and test of rad-tolerant devices will be subcontracted. Finally, the contractor will establish correlation of the effect of silicon dislocations on device yield and gate oxide integrity.

Benefits

This effort will result in a method to measure the silicon (Si) and boron oxide (BOx) layers in Separation by Implanting of Oxygen (SIMOX) wafers and the correlation between layer thickness and defect density. These two pieces will lead to a method for evaluating and characterizing SIMOX wafers that can lead to better process control in the manufacturing of radiation hard electronic components.

Status

Active
Start date: February 1998
End date: February 2000

Resources

Project Engineer:
Donald Knapke
AFRL/MLME
(937) 904-4596

SBIR Funded

Contractor:
IBIS Technology Corporation

JDMTP Subpanel:
Electronics

Conformable Multichip Assembly Technology

Contract Number: F33615-98-C-5149 **ALOG Number: 2043**

Statement of Need

The Materials and Manufacturing Directorate aggressively pursues advances in manufacturing technology which have broad applicability to the affordability and performance of Air Force systems. The focus of this general topic is to allow opportunities for major breakthroughs in the following areas: Composites Processing & Fabrication, Electronics Processing & Fabrication, Metals Processing & Fabrication, Advanced Industrial Practices, and Manufacturing & Engineering Systems. New processing techniques, variability reduction tools, affordability improvements, manufacturing simulation and modeling, are a few examples of the types of proposals that were desired. The emphasis is on innovation, the ability to achieve major advances, and defense/commercial applicability. The objective of this effort is to develop a flexible, high density, chip-scale packaging/assembly technology capable of being bent or twisted to conform to irregular shapes or volume that might be encountered in a space constrained military or commercial electronic system.

Approach

The approach for this effort is summarized as seven major tasks. Task 1 is to explore the critical processes and develop the correct procedures to fabricate chip scale packages (CSPs). Task 2 will define additional flex circuit features including front to back side connections, higher layer count, and impedance control. Task 3 will fabricate the flex circuits defined in Task 2 using the defined processes from Task 1. Task 4 will refine the assembly methods to eliminate difficulties found in the fabrication. Task 5 will select candidate systems for technology demonstration purposes and selection will involve a variety of factors. Task 6 will lay out the CSPs and flex circuits for the demonstrations identified in Task 5. Task 7 will fabricate the conformable system CSPs.

Benefits

Two specific near term objectives for this effort are to: establish a robust manufacturing process for the fabrication of reliable Chip Scale Packages and high performance, high density, multilayer flex circuits and assemblies; and demonstrate the technology for space (or volume) constrained electronic systems' prototypes that are representative of current military products with similar constraints.

Status

Active
Start date: September 1998
End date: June 2001

Resources

Project Engineer:
Charles Wagner
AFRL/MLME
(937) 904-4591

SBIR Funded

Contractor:
Epic Technologies
Incorporated

JDMTP Subpanel:
Electronics

Development of Affordable Optic Chips

Contract Number: F33615-97-C-5124 **ALOG Number: 1538**

Statement of Need

The overall goal of this effort was to reduce the cost of pigtailed integrated optic chips (IOCs), which are a key component used in fiber optic gyros (FOGs), to less than $100 in large volume production (6000 inertial measurement units (IMUs) per year). The objective of this Phase II SBIR was to develop manufacturing technologies for fiber pigtailed lithium riobate integrated optics chips (IOCs) for interferometric fiber optic gyros (IFOG) that will reduce the unit cost to $100.

Approach

The approach was to: achieve single step cut and polish; develop dry polish for silicon V-groove carriers; develop cost effective methods of cleaning and handling of lithium riobate wafers and silicon fiber carriers; and enhance the basic structure of the fiber carriers and the active alignment station to achieve 50DB polarication extinction.

Benefits

Fiber optic gyros have numerous applications in both the commercial and military markets, primarily in the area of navigation (automobiles, airplanes, and ships). Commercial chips are being supplied to two companies and work is planned to improve fabrication and process yield.

Status

Complete
Start date: March 1997
End date: August 1999

Resources

Project Engineer:
Ron Bing
AFRL/MLME
(937) 904-4374

SBIR Funded

Contractor:
Ramar Corporation

JDMTP Subpanel:
Electronics

F-22 Radar Subarray Manufacturing Process Improvements

Contract Number: F33615-97-C-5159 **ALOG Number: 1605**

Statement of Need

The current method of assembling APG-77 F-22 Radar subarrays requires the use of manually soldered flex circuit interconnects to make the numerous radio frequency, digital, and direct current connections between the components that make up the subarray. This flex circuit interconnect process is costly, labor intensive, and has an unacceptably low first pass yield. The objective of this program was to improve the first pass yield, and reduce the cost of the electrical interconnects between the components of the F-22 Radar antenna subarray.

Approach

The approach was to improve the ribbon bond interconnect process currently used in the assembly of radar circulators and apply it to the assembly of radar subarrays. Processes must be improved to enable reliable, repeatable ribbon bonds to be formed at low working temperatures and to incorporate that process into an automated assembly work cell.

Benefits

The objective was to improve the manufacturing assembly yield and decrease the cost of the APG-77 radar subarray. This was accomplished by replacing thousands of costly and labor intensive flex circuit interconnects with improved automated ribbon bonds.

Status

Complete
Start date: January 1998
End date: September 1999

Resources

Project Engineer:
Walt Spaulding
AFRL/MLME
(937) 904-4365

SBIR Funded

Contractor:
Northrop Grumman Corporation

JDMTP Subpanel:
Electronics

Instrument for Rapid Quantitative and Nondestructive Wafer Evaluation

Contract Number: F33615-96-C-5108 **ALOG Number: 1461**

Statement of Need

The importance of detecting and identifying sub-micron defects is due to the present move by the semiconductor industry to manufacture integrated circuits with feature sizes of 0.5 μm, and in the near future with features sizes of 0.25 μm or less. The latter will require the detection of 2 nm substrate defects to 20 nm sized particles on unpatterned silicon wafers. In addition, the industry is scaling up from 200 mm to 300 mm diameter wafer which will require fewer defects and rapid detection per wafer at all processing stages. To have higher yields, defect data must be processed rapidly in real-time to correct processing problems through statistical process control techniques. The objective of this Phase II Small Business Innovation Research (SBIR) project was to develop a rapid in-process wafer surface defect measurement system that can inspect large surface areas in a non-intrusive, non-contact manner to determine the quality of wafer surface.

Approach

The approach was to take the Phase I breadboard of the heterodyne laser optical scanning scatterometer and refine it into a commercial product through extensive requirements definition, system design and prototyping and design of experiments evaluation. The system was demonstrated for SEMATECH and semiconductor manufacturers.

Benefits

The payoff will be significantly reduced cost and improved quality and reliability of semiconductor devices by identifying defective wafers prior to semiconductor integrated circuit processing. The design of the wafer inspection prototype device has been improved by the substitution of an argon laser and by the incorporation of a CCD detector array. These changes will allow analysis of wafer defects to determine the composition of contaminants, and will allow very rapid wafer scans. Both these achievements greatly improve the commercial viability of the device and have resulted in patent applications.

Status

Complete
Start date: July 1996
End date: January 1999

Resources

Project Engineer:
Walt Spaulding
AFRL/MLME
(937) 904-4365

SBIR Funded

Contractor:
Sentec Corporation

JDMTP Subpanel:
Electronics

Light Detection and Ranging (LIDAR) Wind Sensor Manufacturability

Contract Number: F33615-97-C-5145 **ALOG Number: 1498**

Statement of Need

Recent advances in solid-state, diode pumped, coherent lasers which operate at eye-safe wavelengths have made it practical to consider affordable remote wind measurement devices to be installed on military aircraft, airport runways and eventually commercial aircraft. Applications for airborne Light Detection and Ranging (LIDAR) wind sensors include systems which provide a wind-corrected ballistic aimpoint for guns, systems which provide a wind-corrected release point for unguided bombs and missiles, systems which provide wind field measurements for improved airdrop accuracy, systems which measure local air data parameters for avionics and flight control systems, systems which detect wind shear, and systems which measure high altitude winds aloft, aircraft wakes, and clear air turbulence, among other applications. The development of a Doppler LIDAR sensor has enabled the demonstration of these applications and proven the feasibility and advantages of airborne wind field measurement. While these laser sensors are mature enough to consider for production systems, the production of current designs remains labor intensive and requires a high amount of precision hand alignment and tuning. The program's objective is to: enable the transition of an eyesafe LIDAR wind sensor transceiver to a robust, production ready design which can be employed in numerous applications; to leverage the science and technology Integrated Product and Process Development (IPPD) training program; to demonstrate the application of Design for Manufacturing (DFM) and Rapid Prototyping in the transition of the LIDAR system to production; and to address affordability early in the lifetime of the system by application of IPPD principles.

Approach

The approach is to address:

- System modularity to enable multiple applications to be satisfied by a single family of components and greatly reduce mean time to repair.
- System reliability to quantify the relationship between individual components and system reliability in order to identify critical reliability areas in the design phase.
- Integrated product/process development to drive down the skill level required for assembly and test of the laser transceiver with a goal of accomplishing assembly and test in less than 36 hours.
- Component cost reduction with a goal of 85 percent commonality of parts among transceiver designs.
- Low cost maintenance which will enable line replaceable modules and eliminate the requirement for a clean room for routine maintenance.
- Software selectable system characteristics which would allow the laser characteristics to be tailored to satisfy multiple mission applications.

Benefits

This project focuses on manufacturability, commonality of components, and affordability/sustainment and will enable multiple applications to be satisfied by a common family of components. It will reduce or eliminate the amount of precision hand alignment and touch labor required in the production and maintenance of a LIDAR transceiver.

Status

Active
Start date: August 1997
End date: August 2000

Resources

Project Engineer:
Walt Spaulding
AFRL/MLME
(937) 904-4365

Air Force Funded

Contractor:
Coherent Technologies Incorporated

JDMTP Subpanel:
Electronics

Low Cost, High Performance, Low Temperature Co-fired Ceramic-on-Metal Substrates for Mixed Signal Modules

Cooperative Agreement Number: F33615-96-2-5105 ALOG Number: 1528

Statement of Need

The focus of this program was on packaging technologies for mixed signal applications, particularly those applications which combine wireless communication with computing in a compact form factor. One of the challenges of mixed signal packaging is insuring adequate isolation of low level analog signals in close proximity to high speed digital signals. This can be accomplished by incorporating filters into the multilayer substrate itself.

Approach

The objective of this program was to develop the capability to fabricate buried passive components directly into low temperature co-fired ceramic (LTCC) substrates, develop design kits for the buried component technology and to transfer that technology to a high volume substrate manufacturer.

Benefits

By developing the technology to incorporate buried passive devices and filters directly within a multi-layer LTCC-M substrate, very high mixed signal device densities can be achieved in very small form factor packages. Low cost, high performance, mixed signal devices are becoming increasingly important to the DoD as it becomes necessary to distribute more information directly to the individual soldier, munition, or weapon system.

Status

Complete
Start date: September 1996
End date: February 1999

Resources

Project Engineer:
Walt Spaulding
AFRL/MLME
(937) 904-4365

DARPA Funded

Contractor:
David Sarnoff Research Center

JDMTP Subpanel:
Electronics

Manufacturing Technology for Multi-Band Gap Solar Cells

Contract Number: F33615-95-C-5561 **ALOG Number: 1465**

Statement of Need

The cost of a launch vehicle can be as much or more than the satellite it is putting into space. Reducing the launch vehicle's size can cut overall costs by 200 to 300 percent. Even if the launch vehicle size cannot be reduced, a lighter satellite equates to larger amounts of station-keeping propellant loaded aboard, which means a longer service life for the satellite. The objective of this program was to produce monolithic III-V multi-junction solar cells grown on silicon or germanium substrates for space applications. The goal was to escalate yield, increase efficiency, and reduce cost by improving the manufacturing processes of these cells. If the program power efficiency and cost goals are achieved, a 14 percent cost savings per watt can be expected.

Approach

This effort built upon the work done by Phillips Laboratory in developing multi-junction technology, and upon the Air Force Research Laboratory Manufacturing Technology Division's single junction gallium arsenide (GaAs) solar cell program and the gallium arsenide-on-germanium solar cell program. The program had three phases. Phase I defined a baseline to establish current capabilities. In Phase II, the contractor refined the metal organic chemical vapor deposit growth process, among others, using design of experiments and other quality engineering techniques. In Phase III, the contractor validated the process improvements with a final validation production run.

Benefits

The benefit of this effort is the establishment of manufacturing processes for affordable, power efficient, space-qualified multi-band gap solar cells. Average lot efficiencies of greater than 25 percent for large area solar cells have been demonstrated.

Status

Complete
Start date: September 1995
End date: February 1999

Resources

Project Engineer:
R. Susnik
AFRL/MLME
(937) 255-3812

Air Force Funded

Contractor:
Spectrolab Inc.

JDMTP Subpanel:
Electronics

Manufacturing Technology for Multi-Band Gap Solar Cell Array

Contract Number: F33615-95-C-5508 **ALOG Number: 1278**

Statement of Need

The cost of the launch vehicle can be as much or more than the satellite it is putting into space. Reducing the size of the launch vehicle can cut costs by 200 to 300 percent. Even if launch vehicle size cannot be reduced, a lighter satellite means more station-keeping propellant can be loaded aboard which means a longer service life for the satellite. The objective of this program was to enable the production of monolithic III-V multi-junction solar cells grown on silicon or germanium substrates for space applications. The goal was to improve the yield and efficiency, and reduce the cost of the manufacturing processes used in producing these cells while increasing the size of the solar cells to the sizes available in single junction solar cells.

Approach

This effort built upon the work done by Phillips Laboratory in developing multi-junction technology, and upon the Manufacturing Technology Division's work with single junction germanium arsenide (GeAs) Solar Cells and gallium arsenide on germanium (GaAs-on-Ge) Solar Cells. The program had three phases. Phase I defined a baseline to establish current capabilities. In Phase II the contractor refined the growth and other processes using Design of Experiments and other quality engineering techniques. In Phase III the contractor validated the process improvements with a final validation production run.

Benefits

This program allowed the development of more efficient power for space satellite systems (more power for less weight). This will lead to a smaller satellite requiring a smaller and cheaper launch vehicle, at major cost savings.

Status

Complete
Start date: September 1995
End date: March 1999

Resources

Project Engineer:
R. Susnik
AFRL/MLME
(937) 255-3812

Air Force Funded

Contractor:
TECSTAR Corp.,
Applied Solar Energy Division

JDMTP Subpanel:
Electronics

Parts Obsolescense and Reliability Prediction

Cooperative Agreement Number: F33615-98-2-5167 ALOG Number: 2461

Statement of Need

Existing reliability models today have been typically developed for a single, isolated component and have not looked at the system level interactions. These models have typically not been extended to the more stringent military application. To accurately accomplish system level life prediction and estimate component reliability as a part of a credible parts obsolescence plan, there is a need for an integrated toolset that will model the interplay between multiple failure mechanisms and validate the models with field data from commercial products. The objective of this effort is to develop a comprehensive approach to system reliability prediction for electronic components and board level systems in military operating environments.

Approach

This effort will first examine existing failure prediction methods, analyze and upgrade existing software tools developed under previous contract efforts, and develop methodologies to compare reliability prediction with field return data collected on similar components in commercial products. A software package will be developed that integrates multiple reliability models, implements a trained neural network, incorporates a material database including field-return data, and incorporates a graphics user interface. This software tool will be used for predicting total system reliability of both component and board level products in a variety of operating conditions.

Benefits

This effort will build on existing single-mechanism and physics of failure reliability models to develop a software tool that integrates several diverse reliability models and correlates predicted methods with a commercial field return database. This reliability prediction software tool can then be used for selection and qualification of parts obsolescence management.

Status

Active
Start date: February 1999
End date: November 2001

Resources

Project Engineer:
Brandon Lovett
AFRL/MLME
(937) 904-4637

Contractor:
Motorola Incorporated

JDMTP Subpanel:
Electronics

Self-Orienting Fluidic Transport Assembly

Contract Number: F33615-96-C-5111 **ALOG Number: 1448**

Statement of Need

Flat panel display technology must be developed in the United States so that the displays required by the military are available from domestic sources. This program, under the Defense Advanced Research Projects Agency auspices and managed by Air Force Research Laboratory's Manufacturing Technology Division, developed the manufacturing equipment, processes and materials necessary to help establish the domestic manufacturing capability for flat panel displays. The primary objective of this program was to develop a process for the manufacture of high information content displays by fluidic self assembly. The specific objective of this program was the development of a process for economical high volume manufacture of the active matrix portion of an active matrix liquid crystal display using fluidic self assembly of small foundry silicon blocks onto substrates.

Approach

Self-Orienting Fluidic Transport (SOFT) Assembly will create high performance displays, primarily due to the initial fabrication and testing of each element before final assembly. This was a three phase program with Phase I being the basic program and where Phases II and III were options 1 and 2, respectively. Phase I focused on laboratory demonstration of the processes involved. The program developed a complete, scalable and manufacturable prototype process for the manufacture of active matrix assemblies by fluidic self assembly of foundry single crystal silicon, suitable for further processing into active matrix liquid crystal displays using conventional liquid crystal display technology.

Benefits

This technique exploits a fundamental building block to construct a new display. Different sizes and shapes can now be fabricated using the same basic technology to meet the need of low volume custom displays for the military market. This effort will result in higher performance and lower cost of military displays.

Status

Complete
Start date: September 1996
End date: December 1998

Resources

Project Engineer:
Walt Spaulding
AFRL/MLME
(937) 904-4365

DARPA Funded

Contractor:
Beckman Display

JDMTP Subpanel:
Electronics

Advanced Manufacturing & Modeling Simulation (AMMS)

Grant Number: F33615-98-D-5128 **ALOG Number: 1887**

Statement of Need

The Manufacturing Technology Division has a requirement to identify, develop, and demonstrate new computer-based technologies and processes that enhance the affordability of Air Force weapon systems. This requirement is accomplished by working with methods and tools that improve product design and process development efficiencies for manufacturing Air Force weapon systems. The Product Affordability & Realization Testbed (PART) provides a flexible research facility that can develop, assess, and implement computer-based tools that identify costs and risks, perform cycle time analysis, reduce errors, and implement lean principles. The PART is a computer testbed used to conduct experiments demonstrating a broad array of manufacturing software technologies and information tools which support and enhance Integrated Product and Process Development (IPPD). The objective of the research and development effort is to establish, exploit, and advance the potential of the technology and methods available within the PART and to apply PART technology and methods to Air Force Research Laboratory Manufacturing Technology Division (MLM) programs managed at Wright-Patterson AFB, Ohio.

Approach

The contractor shall perform a wide range of technical activities in the area of weapon system affordability and manufacturing risk reduction. These activities include, as a minimum, software and hardware tool evaluation, system analyses, risk and integration studies, technology transition and training, design engineering, prototyping, and engineering testing.

Benefits

- Integration of commercial and developmental modeling and simulation (M&S) tools and methods
- Assessment of technology alternatives for manufacturing affordability using advanced M&S tools
- Assistance to DoD and other customers in understanding the role of advanced M&S in solving specific manufacturing problems

Status

Active
Start date: June 1998
End date: May 2001

Resources

Project Engineer:
Capt. Paul Bentley
AFRL/MLMS
(937) 904-4355

Contractor:
Days Incorporated

JDMTP Subpanel:
Manufacturing and Engineering Systems

Affordable Space System Intelligent Synthesis Technology (ASSIST)

Cooperative Agreement Number F33615-99-2-5902 ALOG Number 2562

Statement of Need:

Low volume production associated with space systems manufacturing is inherently expensive, time consuming, and risk-laden. Typical characteristics of low volume manufacturing such as lack of standard design and common parts, frequent changes to design, costly test environments, and loosely coupled product teams, including suppliers, are obstacles to achieving space systems affordability. At the root of this problem is an inability to adequately predict, monitor, and control the product development and sustainment process. Analysis of these problems revealed that they stem from deficiencies in information technology and management. The primary objective of the ASSIST program is to lower space system acquisition cost through cycle time reductions. Specific milestones are to: (1) develop and deploy the ASSIST framework and tools based on user requirements; (2) validate and demonstrate identified goals of cost, cycle time, and risk reductions by applying the ASSIST technology to A2100 satellite propulsion systems through pilot programs; (3) transition improvements achieved on A2100 to other end users such as USAF SBIRs, Space Operations Vehicle (SOV), NPOESS, Discoverer II, Advanced EHF, and classified programs; (4) disseminate pilot results and establish a plan to migrate validated tools to the space systems manufacturing community through commercialization.

Approach:

The program approach is to select collaborative and information management tools that have been successfully demonstrated in a stand-alone environment and integrate them in an innovative and extendible infrastructure. The resulting environment, which provides a seamless electronic communication system, overcomes enterprise-wide manufacturing cost and time consumption due to limited availability and inefficient use of information. The environment will be demonstrated on real manufacturing problems on the Lockheed Martin Missiles & Space (LMMS) A2100 Satellite Propulsion Subsystem (PSS), which is critical to the standard spacecraft bus used for telecommunications and remote sensing in commercial, civil and military applications. This demo will involve low-volume production and require reduced costs and cycle times in all of the phases of product development. ASSIST facilitates practices documented in the Lean Aerospace Initiative, and the Lean Enterprise Model, to increase team dynamics through all phases of the space system acquisition cycle.

Benefits:

Benefits from this effort include: 50 percent reduction in design cycle time; 10-15 percent reduction in procurement costs; 50 percent reduction in man-hours for test; 50 percent reduction in personnel/hardware exposure time to hazardous operations; 50 percent reduction in launch site test support hours; and a reduction in rework hours to five percent of the total manufacturing hours.

Status

Active
Start Date: May 1999
End Date: July 2001

Resources

Project Engineer:
George Orzel
AFRL/MLMS
(937) 904-4338

Contractor:
Lockheed Martin Corporation

JDMTP Subpanel:
Manufacturing and Engineering Systems

An Adaptable Environment for Parts Obsolescence Management

Cooperative Agreement Number F33615-98-2-5148 ALOG Number 1889

Statement of Need:

The management of obsolete parts within the DoD and specifically the Air Force is a large and growing problem caused by the rapid evolution of electronics technologies within the commercial sector, coupled with long DoD production cycles and life extension programs. The problem is exacerbated by inventory reductions and personnel cuts being felt within the logistics support structure. Similar problems also exist with non-electronic parts as aircraft structures continue to age well past their expected life-cycles. The scope of this R&D project is focused on providing the obsolete parts management community with decision support tools and an integrated business process for making cost-effective obsolete parts management decisions based on consideration of all the relevant variables.

Approach:

This project will review and assess current Air Force parts obsolescence analysis, assessment and decision processes, policies, and practices. This project will focus primarily on practices at WR-ALC, OC-ALC, and OO-ALC. The intent is to identify types of decisions, who makes the decisions, the criteria used by the various decision makers, and how it all fits together in the overall process flows. Findings shall be documented in a business process model, providing a framework for the application of advanced decision support and analysis tools. TASC will deliver a Parts Obsolescence Management Roadmap that will assist system managers by providing the information (tools/processes) necessary to determine the most cost-effective parts obsolescence solution with consideration of many variables. TASC will also adapt their existing Resource Allocation Decision Support System (RADSS) as a stand-alone PC-based program to accommodate unique aspects of the obsolete parts management problems. The resulting tool will provide obsolete parts managers with a usable decision support system for the decision models.

Benefits:

The Parts Obsolescence Management Roadmap provides an integrating vision that takes advantage of currently available tools and information. It also identifies the opportunities for focusing future research activities. The Parts Obsolescence Management Decision Support System meets the critical need for decision support tools flexible enough to address several obsolete parts management decisions, and takes advantage of available information and management insights at various levels of aggregation. Together, these elements significantly improve the current state-of-the-practice associated with parts obsolescence management. Information requirements will include, but are not limited to, decision criteria and supporting information associated with:

- Identification and prioritization of obsolete parts problems
- Assessment of problem impacts on key decision criteria
- Identification of alternative solutions to obsolete parts problems
- Evaluation of cost and benefits of alternative solutions

Status

Active
Start Date: September 1998
End Date: July 2000

Resources

Project Engineer:
Cliff Stogdill
AFRL/MLMS
(937) 904-4350

Contractor:
The Analytical Sciences Corporation (TASC)

JDMTP Subpanel:
Manufacturing and Engineering Systems

Behavior Analog Fault Simulation

Grant Number: F33615-96-1-5603 **ALOG Number: 1422**

Statement of Need

Analog and mixed signal testing follows different test methodologies from digital testing and is a bottleneck that not only leads to high testing costs, but also causes significant 'time-to-market' delays. Testing of mixed signal modules is also exacerbated by the high chip density and small interconnect line dimensions of new multichip modules (MCM). Many of the conventional approaches to testing used for printed circuit boards are not applicable to dense MCM testing, for example bed-of-nails testing techniques. The objective is to develop methodology algorithms and prototype tools for performing behavioral analog fault simulations.

Approach

The focus of this program is to use behavioral modeling for both good circuits and faulty circuits, based on a mixed signal hardware description language, VHDL-A. By exploiting the understanding gained recently in such areas as experimental design, control theory, system identification and applying the latest optimization techniques developed in mathematical optimization, new test algorithms can be developed. Hard-to-detect faults will be identified early in the design phase, which will facilitate design-for-test. New methods will be demonstrated through computer-aided design (CAD) and simulation software tool development.

Benefits

This program will develop a new design methodology that will cut both cost and time spent on mixed signal testing. The goal is to provide more automated test generation during the design phase which will integrate analog and digital testing. The key to this goal is to use fault-driven testing for both analog and digital testing. By isolating difficult to test faults, design-for-test can be used more effectively. This technique also applies to advanced fault detection and fault isolation which maintains mixed signal module manufacturing processes. Project Anoracle is currently developing a comprehensive methodology and a set of software tools to address the design and test challenges of mixed-signal circuits and systems, based on the upcoming IEEE VHDL-AMS (VHSIC Hardware Description Language - Analog Mixed-Signal) standard. Several key technologies have been developed to date, including behavioral model optimization, canonical symbolic analysis, fault simulation and test generation under process variations, rapid fault isolation, and distributed mixed-signal simulation. All these techniques have improved the state-of-the-art significantly, and have been presented at several major electronic design automation conferences, including ICCAD '99, DAC '99, VLSI '97 and EuroDAC '98. An overall of 20 research papers have been published. For one design, using optimization techniques reduces power consumption by over 30 percent. Project Anoracle's research will enable the VHDL-AMS simulation and model based design and test methodology.
See the Project Anoracle Homepage: www.ee.washington.edu/research/mscad

Status

Active
Start date: December 1995
End date: December 1999

Resources

Project Engineer:
Bill Russell
AFRL/MLMS
(937) 904-4583

DARPA Funded

Contractor:
University of Iowa,
University of Washington

JDMTP Subpanel:
Manufacturing and
Engineering Systems

Built-In Test of Known Good Die

Grant Number: F33615-96-1-5610 **ALOG Number: 1423**

Statement of Need

Analog and mixed signal testing follows different test methodologies from digital testing and is a bottleneck that not only leads to high testing costs, but also causes significant 'time-to-market' delays. Testing of mixed signal modules is also exacerbated by the high chip density and small interconnect line dimensions of new multi-chip modules (MCM). Many of the conventional approaches to testing used for printed circuit boards are not applicable to dense MCM testing, for example bed-of-nails testing techniques. The objective of this project was to develop methodology algorithms and prototype tools for performing behavioral analog fault simulations.

Approach

This project researched and developed tools and methodologies for the automation of test pattern generation for mixed signal modules. The project also researched tools and methodologies to determine stuck and delay faults for circuits as a part of known good die development. The Delay Fault Partial-Scan Sequential Circuit Built-In Self-Testing (BIST) developed a nearly automatic way to insert stuck- and delay-fault BIST hardware into a digital military chip with no delay overhead, fast computation times, and five percent chip area hardware overhead. Delay-fault partial-scan sequential BIST allows reliable delay testing of digital defense chips that operate at frequencies >= one Gigahertz, with low chip area overhead. Anyone designing highly-reliable circuits for radar, communication and encryption/decryption should be interested. The Markov-process Sequential Circuit Automatic Test Pattern Generation (ATPG) characterized huge state machines as a Markov process using little memory, but eliminating most test generation backups. The Path Delay Fault Sequential Circuit ATPG developed a path delay fault Sequential ATPG tool to generate test patterns for both stuck- and path delay-fault testing. The Mixed-Signal Analog/Digital Circuit ATPG effort developed a theory and tool that allow ATPG of analog test waveforms for mixed analog/digital chips with properties that: generate waveforms which assist in testing digital and analog parts; select correct frequencies to test for harmonic distortion; and eliminate many analog simulations in the test generation process that are presently needed to generate test waveforms by hand. This method generates the first accurate analog circuit fault models based on the designer's output analog circuit waveform phase and magnitude tolerances. Mixed-signal ATPG is needed for mixed-signal circuits for fire control, guidance, and wireless communication to reduce the cost and trouble of creating analog test waveforms for hardware. Analog Circuit Fault Simulation developed a theory that allows modeling of many noise sources in validating whether a given analog waveform will be useful for analog testing of mixed-signal ckts. Analog circuit fault simulation is useful for mixed-signal military circuits where analog and digital parts reside on one chip. The tool modeled environmental and tester noise, and indicate whether noise will invalidate the testing waveforms.

Benefits

This project provided the tools necessary to provide analog and mixed signal known good die to the industry. Prototype design tools which automate the insertion of built-in test structures for digital microcircuit testing and the generation of tests for external testing were developed.

Status

Complete
Start date: February 1996
End date: March 1999

Resources

Project Engineer:
Bill Russell
AFRL/MLMS
(937) 904-4583

DARPA Funded

Contractor:
Rutgers State University

JDMTP Subpanel:
Manufacturing and Engineering Systems

Collaborative Optimization Environment

Contract Number F33615-96-5613 **ALOG Number 1483**

Statement of Need:

Today, the need for optimization in integrated product and process development (IPPD) is rapidly becoming understood, but the penetration of this technology, particularly for realistic problems, is low. The main reasons for this are that the tools and infrastructure required to support optimization-based IPPD have been slow in their evolution, and the investment required by individual companies to develop and integrate the requisite technologies within their own organizations is too costly, and has an associated high risk. In addition, the optimization technology required to support such a vision has only emerged within the last few years.

Approach:

Under the Rapid Design Exploration Optimization (RaDEO) program, the General Electric Research and Development Center/ Engineous Software team developed a unique Collaborative Optimization Environment (COE) software platform, which provides a key missing technology for developing affordable products with optimum performance through the systematic application of optimization to the IPPD process. Specifically, the COE addresses collaborative optimization along four fronts, including:

- collaboration among optimization algorithms
- collaboration among multiple disciplines (MDO)
- collaboration among multi-level decomposed systems (MLO)
- collaboration among organizations

Benefits:

The COE kernel along with its design automation, integration, and optimization utilities, offers a seamless development environment necessary for engineers to model, analyze, and optimize complex products and processes. It is an order of magnitude faster and more efficient than currently available methods. Specifically, the system contributes to improving product quality, reducing design cycle time, and reducing application development effort. These benefits were demonstrated via two real world applications in the project: an aircraft performance optimization problem and a detailed disk design problem.

Status

Complete
Start Date: May 1996
End Date: March 1999

Resources

Project Engineer:
Brian Stucke
AFRL/MLMS
(937) 904-4397

DARPA Funded

Contractor:
Engineous Software, Inc.

JDMTP Subpanel:
Manufacturing and
Engineering Systems

Collaborative University/Industry Manufacturing Research

Grant Number: Numerous **ALOG Numbers: 1263, 1411-1414**

Statement of Need

The objective of this joint National Science Foundation/Manufacturing Technology funded effort is to stimulate and expand research of Manufacturing Technology using collaborative research among university and industry to create and accelerate the insertion of new technologies into the Department of Defense, aerospace manufacturing and the supporting industrial base.

Approach

This program is strategically focusing university basic research on DoD manufacturing and engineering requirements. The Collaborative University/Industry Manufacturing Research program is an overarching concept intended to build strong academia and industry relationships for development of needed manufacturing technologies. Each individual project is submitted against topics by the university and its industrial partner(s), who collaborate and perform technical work, publish technical papers and develop new text books with real industrial case examples. The industrial partners and the university will exchange personnel ensuring the technology researched is mature as milestones are passed during the life cycle of development. Projects producing "Technology Nuggets" are prioritized and "Pathfinder" development projects are selected and funded. The process renews annually when ManTech and NSF create an announcement containing manufacturing topical areas of interest such as: Affordability Technologies; Rapid Design; and Generative Process Planning. NSF publishes the announcement for potential grants to universities with organized research programs; hundreds respond and many are relevant to ManTech requirements. ManTech selects the highest ranked prioritized relevant proposals, from the NSF Peer Review results, and funds or co-funds with NSF.

Benefits

The program is intended to capitalize on NSF and Air Force Manufacturing Technology strengths across the life cycle, stimulating education processes and improving technology transfer in key market sectors.

Contractor

The following grants have been awarded to universities as part of the joint ManTech/NSF program:

Robust Scheduling and Diagnostics Using Simulation-Based Optimization

(97-1) Georgia Tech will conduct research focusing on scheduling in a real world environment so as to minimize cost. It makes none of the usual idealized assumptions, rather it assumes finite capacities and stochastically affected, variable lead times. The research plan is limited to printed circuit board manufacturing. ManTech should seek to broaden the work to include engine or airframe manufacturing systems.

Optimal Pre-Stressing Surfaces by Superfinish Hard Turning for Maximum Fatigue Life

(97-2) Purdue University will show that under certain conditions of feed, speed and tool condition, compressive stresses are created in the workpiece. This sets the stage for increased fatigue life as well as eliminating the need for grinding and other surface finish operations. ManTech is currently sup-

(continued on next page)

Status

Active
Start date: September 1995
End date: August 2001

Resources

Project Engineer:
David Judson
AFRL/MLMS
(937) 904-4590

NSF/Air Force Funded

JDMTP Subpanel:
Manufacturing and Engineering Systems

Collaborative University/Industry Manufacturing Research

(continued from previous page)

porting this work, which has led to a proposed expansion. ManTech should seek to get the work extended to include titanium and aluminum-lithium alloys.

Optimal Design of Bulk Forming Processes

(96-6) Rensselaer Polytechnic Institute will focus on bulk forming processes such as rolling, extrusion, and forging. Finite element models will be developed for the deformation thermo-viscoplastic-contact problems. Results will be experimentally tested.

Supply Chain Management for Electronics Manufacturing with Product Recovery and Remanufacturing

(96-4) Purdue University will use chain models to support production, purchasing, disassembly and remanufacturing activities over the short term and enhanced planning over the long term. Minimum cost trade-offs for recycling/remanufacturing judgments will be sought.

A Distributed Decision Framework Integrating Manufacturing Planning and Supply Chain Management

(96-3) Lehigh and University of Pennsylvania will create a distributed decision structure which eliminates top-down centralized control and enhances flexibility in dealing with multiple product supply chains. Working with Ford and Lucent, researchers will seek ways to better utilize capital intensive manufacturing equipment.

Proactive Maintenance: Integration of Engineering, Statistics and Operation

The University of Michigan will integrate information from sensors, on-line models, predictions of reliability, cost/risk studies, uncertainty analyses and performance evaluations to achieve an advanced maintenance environment. If successful, this generic piece of research will provide results which can be readily transferred to the defense manufacturing sector.

Continuous Electronics Enhancements using Simulatable Specifications

Contract Number: F33615-93-C-4304 **ALOG Number: 220**

Statement of Need

Currently, fielded systems are delivered with obsolete, or nearly obsolete, electronic technologies. One reason for this phenomenon is that of all the technologies comprising a defense system, the electronics technology undergoes the most rapid change during the course of a system development. An additional problem associated with electronics subsystem development is the presence of integration errors due to human misinterpretation of written specifications. Today integration error rates due to written specification misinterpretation can exceed 60 percent for the integration of microcircuits and multichip modules at the printed circuit assembly (PCA) level of integration. The CEENSS program provides the capability for vendor independent descriptions and designs of electronics products. In so doing, it increases the line replaceable module (LRM) design initial verification and manufacturing success rate and also reduces the development time of electronic systems. This was accomplished through the establishment of methodologies and guidelines for defining, describing, developing, implementing and using simulateable specifications (Sim Specs) via VHSIC hardware description language (VHDL).

Approach

The program developed and demonstrated methodologies and guidelines for Sim Specs and provided a complete electronic product description of LRMs with Sim Specs. The approach further provided for a Sim Spec toolkit through the update of commercial electronic design automation (EDA) tools and their environment which allows for the incorporation of VHDL extensions to support the Sim Spec methodologies. The approach also leveraged ongoing commercial and governmental related electronics programs to provide for the design reuse and prototyping-plus concepts.

Benefits

This effort increased first pass success for the manufacture of LRMs to 95 percent, decreased the presence of obsolete electronics resident in newly delivered systems, and increased reuse of past designs in development of new systems. To date, the CEENSS technology has been employed to design the Pulse Interval Processor (PIP) which is a Communication Navigation Identification (CNI) module. The CEENSS approach to the PIP design has provided direct benefits to the Joint Strike Fighter (JSF) Integrated Sensor Subsystem (ISS) program by providing a viable design and an 18 percent reduction in the design cycle time.

Status

Complete
Start date: September 1993
End date: January 1999
Final Report No.
AFRL-ML-WP-TR-1999-4050

Resources

Project Engineer:
Ted Finnessy
AFRL/MLMS
(937) 904-4434

Air Force Funded

Contractor:
TRW Incorporated

JDMTP Subpanel:
Manufacturing and Engineering Systems

Create a Process Analysis Toolkit for Affordability (PATA) Supporting the R&D Process

Contract Number: F33615-97-C-5141 **ALOG Number: 1569**

Statement of Need

One of the hurdles in applying Integrated Product and Process Development (IPPD) to new technology is quantifying the transition cost and risk impact of critical design or architecture decisions. Determining how risk can be quantified for new technologies, how to base design decisions on process capabilities that aren't fully defined, and how to achieve in software the results being realized in electronics manufacturing, are questions which need to be answered. The Process Analysis Toolkit for Affordability (PATA) is a two year development and commercialization project, intended to be used by the Air Force Science and Technology (S&T) community, including industry, academe, and government, to ensure that research and development projects have viable, usable and affordable results. This Phase II Small Business Innovation Research (SBIR) project developed, validated, and successfully commercialized a high-quality process analysis toolkit that enables life cycle performance cost and schedule affordability analyses, both during the research and development phase of Air Force technology development and during subsequent technology transition to acquisition or support. This effort was specifically focused on addressing the need for a software toolkit to support the S&T IPPD initiative, which aims at achieving more affordable technology by changing S&T culture and business processes throughout the Air Force laboratory environment, by applying IPPD principles to defense research.

Approach

The contractor prepared a project master plan and schedule, business plan, and marketing plan to drive the project. The project was web-based and used a technical review board to remain abreast of industry requirements and developments. The PATA system and training developed were beta tested by the Air Force Material Command/ Advanced Technology Demonstration (ATD) projects. The PATA tools were launched from the web site for testing and commercialization.

Benefits

This effort produced an inexpensive, easy to use toolkit, rich in functionality. It's inexpensive because it takes advantage of the rapidly growing Internet infrastructure. Its unique browser technology and related standards make it convenient and easy to use. It supports a wide variety of activities, from financial transfers (transaction management) to information retrieval, application sharing, collaborative design and decision support.

Status

Active
Start date: September 1997
End date: August 2000

Resources

Project Engineer:
David Judson
AFRL/MLMS
(937) 904-4590

SBIR Funded

Contractor:
James Gregory Associates, Inc.

JDMTP Subpanel:
Manufacturing and Engineering Systems

Electric Component Commerce

Cooperative Agreement Number: F33615-96-2-5116 ALOG Number: 1553

Statement of Need

Electronic systems and subsystems represent about 40 percent of the defense acquisition budget and are the critical enabling technology that differentiates our weapon systems. As the Department of Defense (DoD) downsizes, it has become increasingly important to keep access to affordable, advanced electronics technology by leveraging the high volume, leading edge, merchant manufacturing infrastructure. Historically, unique DoD requirements and relatively small production volumes have been incongruent with the merchant community's focus on high volume commodity products. Digital Market seeks to alleviate those barriers by increasing the flexibility of the merchant ESM infrastructure and streamlining the process by which new products are designed, sourced, and transferred to manufacturing.

Approach

To achieve this goal, Digital Market built an on-line marketplace (digital.market) for electronic components that connects engineering and procurement organizations directly to their preferred distributors to exchange information and transactions in real time. A buyer or engineer can upload a Bill of Materials (BOM) and forecast information directly into digital.market and quote and order components in real time from multiple distributors. This accelerates the process and lets high volume ESMs cost effectively procure material for low volume DoD manufacturing projects where manufacturing times are dominated by component procurement, prototype fabrication cycles, producability analysis, and production setup times. Additionally, the ESMs decrease their design-build-test cycle time and ramp faster from prototype to volume manufacturing.

Benefits

The system has demonstrated a 38 percent reduction in the overall cost of acquiring and managing materials, faster and more accurate information sharing in the supply chain, greater ability to respond to changes in engineering content and demand schedules, and immediate access for small quantity purchases. A pilot project at Solectron demonstrated the benefits of these tools. The benefits were captured by a Standford University Business School study. The study will appear in the final report. As digital.market gains more acceptance in the contract manufacturing segment, these efficiencies will be exploited to reduce the cost of manufacturing a large portion of future DoD and commercial products.

More information is available at the digital market homepage: www.digitalmarket.com

Status

Complete
Start date: October 1996
End date: December 1998

Resources

Project Engineer:
Bill Russell
AFRL/MLMS
(937) 904-4583

DARPA Funded

Contractor:
Digital Market

JDMTP Subpanel:
Manufacturing and Engineering Systems

Electronic Component Information Exchange

Cooperative Agreement Number: F33615-97-2-5121 ALOG Number: 1527

Statement of Need

Component suppliers world wide desire to reach the global marketplace, and customers of electronic components want easy access to supplier information. The rapid expansion of the Internet has offered a practical technology infrastructure to support rapid information distribution. Through use of the electronic information distribution, data can be revised and broadcast immediately, without the expensive, time-delayed characteristics of today's publishing practices. However, without a degree of standardization for the form and content of these electronic packets of component data, customers will be unable to compare value across multiple suppliers, and could be required to re-key data from the selected supplier to make component data available to computer-aided design (CAD) systems used for the product design. The objective was to provide an overall architecture and set of standards which support the flow of reusable electronic component information from its source to the user.

Approach

The project was implemented as an industry partnership under Silicon Integration Initiative (SI2) bylaws. It was be led and managed by SI2 staff in partnership with sponsoring industry partners. Members of this partnership include Texas Instruments, IBM, Hewlett Packard, and Xerox. Development will be performed by technical workgroups staffed by the member companies and under the direction of a project technical advisory board (PTAB). The PTAB is represented by each sponsoring company equally and had responsibility of setting priorities and design decisions during the development phases to assure rapid closure. SI2 provides the lead for the overall architecture of the system and two technical workgroups were responsible for the PCIS and CIDS development.

Benefits

The payoff is a professionally documented architecture for a standards-based system supporting electronic commerce of electronic components, and a formally balloted (through SI2 membership) set of standards which support that architecture. Additionally, this project provided a commercially available suite of tools that operate with these standards to provide the open electronic commerce system architecture. These tools were developed to prove and initiate widespread adoption of the standards within industry and to encourage competitive offerings over time. Finally, a proof of the viability of the commerce system was provided by a formally documented test run by a major government contractor with results that clearly identify quantitative comparison with currently used approaches. More information is available at the Electronic Component Information eXchange homepage: www.si2.org/ecix

Status

Complete
Start date: December 1996
End date: December 1999

Resources

Project Engineer:
Bill Russell
AFRL/MLMS
(937) 904-4583

DARPA Funded

Contractor:
Silicon Integration Initiative

JDMTP Subpanel:
Manufacturing and Engineering Systems

Electronics CAD-CAM Exchange

Contract Number: F33615-96-C-5118 **ALOG Number: 1524**

Statement of Need

It is estimated that the electronics industry spends well over $150 million a year to capture design data and transport the information into the CAM environment. ECCE was a Defense Advanced Research Projects Agency (DARPA) funded program which developed and demonstrated an integrated solution to providing compatibility between Computer Aided Design (CAD) and Computer Aided Manufacturing (CAM). The goal of the ECCE program was to design a format for carrying CAM information (CAM-F) in a way that ensures a viable, sustainable method of CAD/CAM and CAM/CAM information transfer. ECCE also demonstrated how the CAM information model can be populated with CAD data, enabling error-free transfer of data from CAD to CAM.

Approach

The ECCE technical approach applies the formalisms of information modeling to CAM. ECCE created an information model, from the "manufacturer's point of view," that documents CAM information requirements. The CAM information model was mapped to the CAD information model, as represented by EDIF 4.0.0. With the concurrence of the EIA and the Institute for Interconnecting and Packaging Electronic Circuits (IPC), ECCE initiated changes to Electronic Design Interchange Format (EDIF) to better support CAD-CAM exchange.

Benefits

By conservative industry estimates the lack of accurate CAD information to manufacturing costs U.S. industry $150 million annually in reengineering and scrap costs. The results of this project will greatly reduce this number if embraced by the users. The information model and format will be made a joint EIA and IPC standard. More information is available at the ECCE homepage: www.inmet.com/ecce

Status

Complete
Start date: December 1996
End date: March 1999

Resources

Project Engineer:
Bill Russell
AFRL/MLMS
(937) 904-4583

DARPA Funded

Contractor:
Averstar, Inc.

JDMTP Subpanel:
Manufacturing and Engineering Systems

Fast and Flexible Communication of Engineering Information in the Aerospace Industry

Contract Number: F33615-94-C-4429 **ALOG Number: 1251**

Statement of Need

This project aimed to improve key processes in the aircraft industry by following a bottom-up process. At the same time, it deepened understanding of the top-level concepts of agility. Aerospace components and assemblies are procured through a complex web of parts and tooling suppliers. Crucial information necessary for part fitup and product performance can be lost in this web, necessitating extensive problem-solving activities. Speed and flexibility can be improved by examining both the problem-solving processes and the underlying customer-supplier relations. This program was coordinated with a parallel one in the automotive industry (Contract Number: F33615-94-C-4428, Fast and Flexible Design and Manufacturing Systems for Automotive Components and Sheet Metal Parts) to provide cross-fertilization, leveraging of common research activities, and adoption of best practices from both industries.

Approach

Fast and flexible business activities are characterized by: organizing for change, virtual partnerships, valuing knowledge and skills, and enriching the customer. This project deepened understanding of these characteristics by studying specific assemblies built for and obtained from other companies. The methods used were process mapping to identify crucial transactions between people and companies, linking transactions to clusters of specific engineering data called features, identifying transactions that do not add value, identifying and inserting missing transactions, and speeding up the processes by providing computer tools and database access that connect people and their transactions to engineering features. Aerospace items are highly engineered, made in low volumes, and subject to government procurement rules and intense regulation. Items studied include commercial and military fuselage and engine inlet assemblies, empennage assemblies procured from foreign sources, and examples of both paper and computer-based design data. This variety gave the study generality. Conditions observed include use of legacy data, problem-solving and sustaining engineering on old programs, coordination of key characteristics up and down the supply chain, and emergence of new design methodologies alongside the old ones.

Benefits

- Tools and methods to identify critical information needed to support important transactions.
- Improved learning curve and first time capability in manufacturing.
- Increased attention early in the design process to factors that will affect downstream performance.
- Faster problem-solving, better root cause analysis, and fewer change orders.
- Reduced cost and improved quality.

Status

Complete
Start date: June 1994
End date: August 1999

Resources

Project Engineer:
George Orzel
AFRL/MLMS
(937) 904-4338

DARPA Funded

Contractor:
Massachusetts Institute of Technology

JDMTP Subpanel:
Manufacturing and Engineering Systems

Flexible Environment for Conceptual Design

Contract Number: F33615-96-C-5617 **ALOG Number: 1484**

Statement of Need

The objective of this project was to develop and demonstrate an integrated set of flexible engineering analysis and design tools for supporting conceptual design of complex engineering systems. This project sought to build a computer environment which can tightly integrate analysis across multiple disciplines. It has the flexibility to let the analyst quickly explore new opportunities as they arise by making it as simple as possible to extend and/or modify analysis models.

Approach

This effort included research and development in design and analysis methods, with particular emphasis on: constraint management and non-linear solution methods including enhancements to the functionality of "Design Sheet"; implementation of new and enhanced methods in software for providing distributed access to the conceptual design tools and their models; and, investigation of techniques for integration of the resulting prototype software with other existing commercial tools used by designers. Challenging design exercises on Department of Defense relevant systems were undertaken: currently, it is being used for the exploration of NMD/LSI concepts. It is being used in a large joint study of SBIRS-low architectures. It is the high-level trade tool used in doing UCAV studies for the Air Force and it is part of the High-Energy-Laser effort, Reusable first-stage launch vehicle studies, Joint Strike Fighter, and many more proprietary programs.

Benefits

This program developed an advanced design environment based on constraint-based reasoning that, within a given time window, allows for an order of magnitude more design alternatives to be considered during the early stages of a design program. This environment provides unique support for multi-disciplinary trade-off analyses and Design-to-Cost studies. Tools developed in this program are focused on the earliest stages of the design where the value of a good design decision has the greatest leverage.

Status

Active
Start date: June 1996
End date: January 2000

Resources

Project Engineer:
Daniel Lewallen
AFRL/MLMS
(937) 904-4343

DARPA Funded

Contractor:
Rockwell International Corporation

JDMTP Subpanel:
Manufacturing and Engineering Systems

Integrated Knowledge Environment - Integrated Product Management

Contract Number: F33615-96-C-5109 **ALOG Number: 1462**

Statement of Need

There is a need for innovative acquisition tailoring and alternative development processes for program management tools. Users need reference libraries that contain standards, handbooks, templates, guidelines, etc., which are accessible over local and wide area networks. There is also a need for tools that automatically produce tailored project plans and schedules from process model templates which contain systems engineering/configuration management activities for the various engineering and manufacturing disciplines. The objective of this project was to use the results of the Phase I research and extend the Integrated Knowledge Environment-Integrated Product Management (IKE-IPM) framework. The IKE-IPM is a framework for managing acquisition and sustainment projects and processes and for assessing the cost schedule, performance and risk associated with product development.

Approach

The IKE-IPM tools are based on the flexible framework of Phase I, which developed the capability to use integrated tools to enable project, process and product life cycle cost, risk and affordability analysis and management. The contractor developed the new IKE-IPM application, Object Czar (OZ). It provides capabilities to maintain individual and distributed work breakdown structures, organization structures, project structures, etc., and allows users to dynamically define object properties and immediately update them with values.

Benefits

The IKE-IPM application provides Virtual Manufacturing Enterprise users with a mechanism that will facilitate rapid development and distribution of planning and metric information, and facilitate the tracking of production status throughout the entire process. Oz allows users to:

- create collections that contain object instance relationships
- produce reports using rapid report generation capabilities
- define numeric object roll-up properties to determine cost, risk, weight, and other quantitative characteristics
- define object metric color roll up properties, to alert management of project status associated with processes and products
- link one or more views to any object in the hierarchy.

Status

Active
Start date: May 1996
End date: January 2000

Resources

Project Engineer:
David Judson
AFRL/MLMS
(937) 904-4590

SBIR Funded

Contractor:
Knowledge Base Engineering Inc.

JDMTP Subpanel:
Manufacturing and Engineering Systems

Internal Real-Time Distributed Object Management System

Contract Number: F33615-96-C-5112 **ALOG Number: 1442**

Statement of Need

Data processing in the heterogeneous manufacturing information systems environment is cumbersome and time consuming. When users of the system require data from the network, they spend considerable time searching for the needed data, and even when they find this, it is often difficult to obtain the data in proper electronic form. The objective of this project was to establish a real-time communications service internal to Common Object Request Broker Architecture (CORBA) services, supporting the application user and external user sites. This Internal Real-Time Distributed Object Management System (IR-DOMS) had to resolve heterogeneous platform issues and provide the end user a seamless reliability capability to perform their jobs.

Approach

The approach developed a commercial prototype software product called ORB_IT (Object Request Broker - Integration Technology), that facilitated "seamless" and "transparent" computing and data processing in a networked environment. Phase II used and enhanced the real time architecture established in IR-DOMS Phase I; each computing node is a client and also a server available over standard fiber channel based giga-bit and conventional networks. Object Management Group's (OMG) ISO Standards was used. The Object Request Broker (ORB) supports user applications and the Common Object Services Specifications (COSS) functions provides capabilities required by the ORBs across different computers. A Technical Review Board (TRB) and multiple beta implementation sites were established for IR-DOMS validation during the project. These sites demonstrated commercial components products and systems in their production facilities.

Benefits

The ORB_IT technology is being transitioned as Fiber Express™, a recently introduced giga-bit network which can provide high bandwidth communication and real-time performance in a heterogeneous networked environment. The IR-DOMS technology can be used in any information systems environment and by any manufacturer to support the production of products for virtually any market including the process industries, automobile, petroleum, medical, aerospace, home and business appliances, electronics and utilities.

Status

Complete
Start date: March 1996
End date: September 1999

Resources

Project Engineer:
David Judson
AFRL/MLMS
(937) 904-4590

SBIR Funded

Contractor:
Systran Corporation

JDMTP Subpanel:
Manufacturing and Engineering Systems

Laminated Object Manufacturing-Based Design for Ceramic Composites

Contract Number: F33615-98-C-5121 **ALOG Number: 1894**

Statement of Need

A need exists for the development of an innovative design environment in which the use of Laminated Object Manufacturing (LOM) solid freeform fabrication (SFF) will provide significant improvement to the product development cycle for ceramic matrix composites (CMC). Current design practice for CMC is hindered by lack of sufficient material property data and by the limited understanding of composite failure behavior. Consequently, CMC designs are overly conservative and expensive, and CMC utilization in structural applications is limited. This effort involves the development of a design process that will enhance the structural efficiency and reduce design time and cost for aerospace CMC components. These advantages will accelerate the application of CMC components on advanced DoD systems.

Approach

This effort consists of three main tasks: a Design Methodology Development Task for LOM based prototyping, a LOM CMC Process Validation Task, and a CMC Prototype Demonstration Task. The design methodology task contains three computer-aided design (CAD)/ LOM related sub-tasks that include software interface development, CAD design procedure evaluation, and a design methodology effort. The second task is directed towards extending the capability of the LOM technique to fabrication of large curved shapes typical of large aerospace components and includes CMC material and system process development activities and equipment modifications. The third task involves a demonstration of the usefulness of the LOM-based design methodology. The modified LOM system will be used to fabricate sub-components designed in the first task. The results from subsequent sub-component testing will be incorporated into the design methodology database to aid in the design definition of the demonstration component that will be designed, fabricated, and tested in the final task. The demonstration component is an engine exhaust washed high temperature blast shield representative of structures anticipated to be used on future military vertical short takeoff and landing (VSTOL) and low observable (LO) aircraft with shielded exhaust.

Benefits

This effort will develop and demonstrate a paperless design methodology using LOM-based processing to fabricate complex CMC structural components. The approach involves the development and integration of two fundamental capabilities. The first capability includes modification of the CAD process to include prototype fabrication, and the development of interfaces between the design software environment and the appropriate prototyping system. The second capability involves the development of LOM processes that are applicable for typical continuous fiber CMC aerospace structures.

Status

Active
Start date: May 1998
End date: May 2000

Resources

Project Engineer:
Jon Jeffries
AFRL/MLMS
(937) 904-4353

DARPA Funded

Contractor:
Northrop Grumman

JDMTP Subpanel:
Manufacturing and Engineering Systems

Life Cycle Costs of Manufacturing Activities and Technological Innovation

Contract Number: F33615-96-D-5608 **ALOG Number: 2381**

Statement of Need

Adequate support equipment is one of the most important system requirements of logistic centers. Equipment needs are reviewed on a continuous basis. There is a requirement to provide economical depot maintenance support to operational activities while minimizing the cost of industrial equipment ownership. In an effort to make the depots more competitive, minimize the cost of equipment ownership, and place the depots in a business like posture, new technologies to achieve lean logistics must be sought. Knowledge Based Systems, Inc. (KBSI) has teamed with Texas A&M University (TAMU), Oklahoma City Air Logistics Center (OC-ALC), and Corpus Christi Army Depot (CCAD) to transition National Science Foundation (NSF) MOTI project results into daily application and beyond into the commercial market and the engineering education program. The program is referred as Accelerated Technology Application of Cost Knowledge (ATACK). The objective of the ATACK program is to successfully refine, produce, deploy, and demonstrate the viability of affordability prediction technologies in the production maintenance and re-manufacturing environment.

Approach

The approach leverages specific ManTech and OC-ALC technological and Cost Modeling Methodologies for the rapid acquisition, propagation, and utilization of comprehensive cost knowledge across the depot maintenance and repair domain. The effort also leverages over ten years of KBSI SBIR and privately funded research results and commercial enterprise modeling tool technology.

Benefits

ATACK will accelerate existing cost modeling methods and technologies. The results will be put into practice. Associated educational resources necessary for reducing technology insertion cycle times by up to 50 percent will be created. It will also produce viable commercial products, model templates, and reusable model components to greatly accelerate and simplify affordability analysis.

Status

Active
Start date: September 1998
End date: February 2000

Resources

Project Engineer:
David Judson
AFRL/MLMS
(937) 904-4590

Contractor:
Knowledge Based Systems Incorporated

JDMTP Subpanel:
Manufacturing and Engineering Systems

Manufacturing Simulation Driver

Contract Number: F33615-96-C-5609 **ALOG Number: 1481**

Statement of Need

The overall objective of the Rapid Design Exploration and Optimization (RaDEO) program is to develop engineering tools and information integration capabilities that could be used to evaluate an order of magnitude more design alternatives than is possible today in an attempt to optimize several product characteristics, and quickly prototype complex products and processes. As part of RaDEO, the objective of the Manufacturing Simulation Driver (MSD) program is to develop, validate, and demonstrate the use of Factory Simulation to explore and compare alternative design approaches, alternative workflows, outsourcing of specific operations, and alternative internal and external factory utilization.

Approach

Factory simulations were created using the STEP standard as a foundation for product/process modeling, manufacturing knowledge bases and simulation engines. The MSD program built extensions to the STEP standard that enable the capture of a manufacturing enterprise model to the level where descriptions of processes and resources are robust enough to support driving an enterprise level simulation. The STEP model will lead to the development a software interface to a set of Deneb simulators. The program concluded with a concept demonstration.

Benefits

The MSD program can evaluate simulation metrics, continuous product design refinements, as well as timely and cost effective design and production methods. The effort included the Common Object Request Broker Architecture (CORBA) and Standard for the Exchange of Product Model Data (STEP) Application Protocol 213 into the common integrated database needed to support the simulation driver was successfully completed. This open systems solution is currently being demonstrated and tested at the National Institute for Standards and Technology (NIST) Manufacturing Engineering Laboratory to validate the broad applicability of the database technology and simulation tools.

Status

Complete
Start date: April 1996
End date: September 1999

Resources

Project Engineer:
John Barnes
AFRL/MLMP
(937) 904-4391

DARPA Funded

Contractor:
Raytheon Company

JDMTP Subpanel:
Manufacturing and Engineering Systems

MEREOS - A Product Definition Management System

Contract Number: F33615-95-C-5519 **ALOG Number: 1370**

Statement of Need

Almost all manufacturing enterprises producing complex products develop separate engineering, manufacturing, and logistical or field support product definitions, in order to support various engineering, manufacturing and maintenance activities. Each of these configurations inevitably differ from one another both in form and in content. These differences mark the presence of certain kinds of relations that span bills of material (BOMs). The task of reconciling multiple BOMs for a product involves identifying components that stand in counterpart relations across them, and characterizing the properties of those relations. Establishing counterpart traceability is essential for managing engineering change. Managing this process is possibly the most complex and costly activity in a manufacturing enterprise. The multiple BOM phenomenon exacerbates this already difficult problem, since the impact of changes to a component in one BOM must be determined for all of its counterparts in any other BOMs. There is a direct linkage between the multiple BOM reconciliation problem and the high costs and long lead times associated with engineering change. Product data is the centerpiece of manufacturing enterprise information assets. The objective of the MEREOS project is to develop a product definition management system based on PACIS®, a next-generation ANSI/ISO database management system. The goal of the system is to solve the multiple bill of materials reconciliation problem in large-scale, complex product manufacturing environments. The specific objective is to provide end users with the ability to define, modify, query, and automatically maintain relationships between several distinct BOMs, specification trees, and functional structures for a single product, where the information involved is stored in databases.

Approach

The approach for solving the multiple bill of materials reconciliation problem involves the development of a product definition management system specifically designed to automate counterpart traceability across distinct BOMs for a given product. This system is designated MEREOS and will be implemented as an application hosted by PACIS®, a database management system based on the ANSI/ISO 3-schema architecture. Three broad capabilities will be supported with MEREOS: product structure definition and management; process structure definition and management; and technical document creation and integration. Each of these capabilities will be delivered as an integrated suite of functions within a single application system running on UNIX® workstations and employing extensive interactive graphical interfaces.

Benefits

MEREOS can be used in a number of different ways. A systems engineering organization could use it to support automated requirements analysis, decomposition, and traceability. A program management office or product group could use it as the core of a status accounting system. Manufacturing or logistics engineering groups could use the system as an application for defining "as-planned" or "as-supported" structures whose elements must be traceable to "as-designed" components and functional requirements. Finally, an information systems organization could use the system as a tool for update dissemination and database integrity maintenance in environments that have different system managing different versions of product structures.

Status

Active
Start date: December 1994
End date: May 2000

Resources

Project Engineer:
Daniel Lewallen
AFRL/MLMS
(937) 904-4343

Air Force Funded

Contractor:
Ontek Corporation

JDMTP Subpanel:
Manufacturing and Engineering Systems

Missile Industry Supply Chain Technology Initiative (MISTI)

Contract Number: F33615-96-C-5115 **ALOG Number: 1522**

Statement of Need

Fifty percent of missile production cost lies in the supply chain below the prime contractor level. Large percentages of the time required for missile acquisition are consumed configuring and utilizing that supply chain to find the necessary information to design, produce, and support parts and services that meet missile system requirements. Attempts to introduce new technology (e.g., Electronic Data Interchange (EDI)) to improve the way in which the supply chain functions have been frustrated by: (1) the size, complexity and diversity of the supplier population (a mix of high and low levels of technological sophistication); (2) the inflexibility of EDI standards; (3) the inadequacies of the tools supported by those standards; and (4) the anticipated need to accommodate low-volume, multi-missile production in the future. The objective of the MISTI program was to define, develop, implement, demonstrate, and quantify the benefits of a set of innovative, high-impacting tools and technologies which utilize the Internet to create an agile integrated missile supply chain. Technologies and services resulting from work were integrated and deployed into a series of metricized alpha tests to demonstrate their widespread applicability and impact for efficient supply chain integration in support of the AM3 goals of significant missile sector acquisition cost reduction, time compression, and quality improvement.

Approach

The contractor: developed the basic technology necessary to create and maintain a universal catalog protocol (UCP) and a universal catalog gateway (UCG) infrastructure to facilitate creating, populating, integrating, and maintaining distributed web-based mega catalogs; built and populated an initial set of missile industry catalogs; and pursued an aggressive technology transfer and commercialization plan to ensure widespread availability of technologies, services, and applications.

Benefits

Using the UCG, missile contractors were able to: (1) rapidly configure a supply chain; (2) locate, select and customize components; (3) search and determine best matches among components available in the supply chain and any set of designer-specified requirements, while automatically verifying the associated integration requirements; (4) dynamically create a Web-distributed federated object model (FOM) of an evolving missile product design; (5) generate product realization plans (Bills of Processes) for alternate designs; (6) rapidly estimate the total acquisition cost increment associated with a P3/supplier choice; (7) exchange models, simulations and production data; (8) integrate and manage design trades across the supply chain; and (9) launch COTS and contractor-specific engineering, production and business applications that utilize design and production data from the supply chain.

Status

Complete
Start date: November 1996
End date: March 1999

Resources

Project Engineer:
Jon Jeffries
AFRL/MLMS
(937) 904-4343

DARPA Funded

Contractor:
Science Applications International Corp

JDMTP Subpanel:
Manufacturing and Engineering Systems

Mixed Signal Test (MiST)

Cooperative Agreement Number: F33615-95-2-5562 ALOG Number: 1346

Statement of Need

The availability of submicron CMOS technology, precision bipolar capability, and multi-chip modules (MCMs) continues to increase the complexity of analog and mixed-signal designs. Along with this increase in density and complexity come several challenges in developing test prototyping, production, and trouble shooting. The first challenge relates to complexity, density, lack of access to constituent ICs, and the need for interconnect testing. The second has to do with the specification-driven nature of test procedures for mixed-signal circuits which poses two major problems. First is that under-specified systems specification testing results in test programs with insufficient analog fault coverage for high quality products. Second is the inability to diagnose an out-of-specification system due to a lack of connection between specifications and component failures. Finally, there is the challenge of having to synchronize digital and analog test resources to test a mixed-signal circuit. The objective of this project was to develop a set of integrated design and test tools for the development of mixed signal multi-chip modules and printed circuit boards.

Approach

In this program, the contractor proposed to solve the above problems by expanding the capability of the IMS MCM Test Development System (TDS) to incorporate specification testing in the design hierarchy and relating it to the underlying analog fault models. Mixed-signal scan and multiplexing techniques were introduced into the design-for-test process to enhance accessibility. The development and demonstration of control and observation test structures for analog devices was also accomplished.

Benefits

The availability of test development tools and technologies integrated with mixed signal design environments will significantly decrease the test development efforts associated with production and support. See the MiST Consortium Homepage for more information: www.ee.washington.edu/mad/mist/mist.html

Status

Active
Start date: September 1995
End date: February 2000

Resources

Project Engineer:
Bill Russell
AFRL/MLMS
(937) 904-4583

DARPA Funded

Contractor:
Boeing Company

JDMTP Subpanel:
Manufacturing and Engineering Systems

Net Shape Casting Production Machine

Contract Number: F33615-97-C-5123 **ALOG Number: 1546**

Statement of Need

Under Phase I, Metal Matrix Cast Composites, Inc. developed a process to integrate design and solidification modeling into a near-absolute net-shape casting production machine. This research is novel in that components begin as CAD solids models and are sent via a communications link to Oak Ridge National Laboratory for FEA and solidification analysis. The data is then sent back to MMCC to a CNC for mold creation and finally cast to near-absolute net-shape; at MMCC. The changes in process and using the ISO-STEP standards are the first steps in the integration of mechanical processes, materials and computer technology standards. This enables a move towards the technology shift in manufacturing required to advance the state of the art and move manufacturing in the direction of a major paradigm shift. The objective of this project was to use the Advanced Pressure Infiltration Casting (APIC™) process as a low cost method of manufacture for cast metal matrix composite components.

Approach

A liquid-cooled hollow brake rotor for flight-line tow tractors is the component which was developed to demonstrate the technology during the first year. A bench scale water vaporization cooled aircraft brake rotor was used to demonstrate rapid redesign/reengineering features of the Net Shape Casting System, during the second year. MMCC installed SDRC's Finite Element Analysis software to analyze stress and strains throughout a part, so part designs can be readjusted to best utilize a composite's properties and optimize these for minimum weight.

Benefits

The Air Force benefits from having available new technology that can decrease the delivery time for parts to the point of need in the field. This work will lead to reductions in cost of producing both simple and complex formed products. MMCC is involved in licensing APIC technology to the automotive industry and heavy equipment manufacturers. Greater integration will make the process more flexible and prototyping will be more rapid and more representative of true large scale manufacturing. Applications include automotive, aerospace, marine, and sporting goods. These applications all require high performance materials at low cost. The Defense Advanced Research Projects Agency and the Navy have awarded a contract to develop this technology as an on-board part production facility. ManTech will participate in this and is studying Air Force impact of this technology and its applications for small parts production.

Status

Complete
Start date: April 1997
End date: August 1999

Resources

Project Engineer:
David Judson
AFRL/MLMS
(937) 904-4590

SBIR Funded

Contractor:
Metal Matrix Cast
Components Consortium,

JDMTP Subpanel:
Manufacturing and
Engineering Systems

New England Supplier Institute

Cooperative Agreement Number: F33615-94-2-4424 ALOG Number: 1228

Statement of Need

The Corporation for Business, Work, and Learning is leading a six-state, industry-driven consortium, the New England Supplier Institute (NESI), in a pilot program which is identifying, coordinating and delivering technology deployment services to the region's supplier base.

Approach

NESI helps small- and medium-sized firms keep pace with the requirements of their customers, with changing technologies, and with product/market requirements. Services are delivered in New England through local partners and offer a portfolio of tools and techniques that can be uniquely targeted to the needs of an individual supplier. NESI also builds mentoring partnerships between suppliers and customers. By its third year of operation, NESI had served approximately 750 firms.

Benefits

This program significantly contributed to the Air Force's knowledge base concerning customer-supplier relationships. This program developed, supported, and ran many successful workshops for small and medium suppliers in the New England region. Many participants of these workshops went on to implement advanced purchasing and manufacturing practices. Specific benefits include:

- Improved competitiveness of defense related OEMs and suppliers in six New England states
- Diversified business base of defense dependent subcontractors
- Established a model for coordinating services across state boundaries

Status

Complete
Start date: August 1994
End date: December 1998

Resources

Project Engineer:
Wallace Patterson
AFRL/MLMS
(937) 255-9438

DARPA Funded

Contractor:
Corporation for Business, Work, and Learning

JDMTP Subpanel:
Manufacturing and Engineering Systems

Oregon International Internship Program

Cooperative Agreement Number: F33615-95-2-5552 ALOG Number: 1466

Statement of Need

In looking to the future, it is clear that more effort needs to be given to peace-making and peace-keeping initiatives including training that contributes to economic competitiveness and an improved understanding of the methods, processes and procedures in other countries that are relevant to changing security needs in the U.S. A key component in developing an affordable solution to meeting the demands of the 21st century is to foster the integration of international internship experiences into areas that are relevant to our future security as a nation and that have not previously been internationalized — the sciences, professional schools and technical programs. These academic areas are critical to U.S economic and scientific competitiveness, but their programs generally do not reflect the importance of the field's international dimensions. Events outside the U.S. are changing the nature of the professions and the U.S. preeminence in these areas is being challenged by overseas competitors. In fact, every undergraduate needs to have the opportunity to acquire an international dimension to their academic degree. The objective of this program is to develop an affordable solution to meeting the demands of the 21st century to foster the integration of international internship experiences into areas that are relevant to future security that have not been internationalized.

Approach

The Oregon State System of Higher Education (OSSHE) consists of eight institutions of higher learning located throughout the state of Oregon. Part of the OSSHE mission is to internationalize Oregon's higher education institutions. OSSHE has pursued this goal by establishing centers of excellence to address global problems. OSSHE, in cooperation with Oregon Economic Development Department (OEDD), will structure an international internship program to establish quickly and efficiently an effective network of contacts and opportunities to capitalize on the developments that are occurring in international manufacturing, engineering, management, environmental studies and other disciplines. The OSSHE institutions currently coordinate academic exchange programs with 50 partner institutions in 16 countries. Students who complete study abroad are prime candidates for international internships. The International Internship Program built on this existing OSSHE network of international exchange programs to identify internship placement overseas. As of August 31, 1998, 427 students had been placed in internships throughout the world, with 179 placements in the last year. The international internship program continues to provide access to overseas experiences for a broad diversity of students, including ethnic minorities, non-traditional students and students with disabilities. Internships are well balanced among the academic disciplines and include large portions of previously under represented specialties, particularly in the areas of science and technology.

Benefits

The International Internship Program provided students with internship opportunities in their field, both in domestic and international settings. Students began their internships with a participating Northwest business or agency for three weeks before joining a comparable organization in a host country. Following their international internships, the students returned for an additional three weeks with the cooperating organization. This design offers advantages to the students and cooperating business or institution. The students get valuable "hands-on" training and a cross-cultural perspective on their profession. The businesses benefit from the returning students' technical and cultural insights into a comparable international business, and from the contacts the student establishes while in-country. Finally, the U.S. company benefits by having an opportunity to train a potential new employee at minimal cost.

Status

Complete
Start date: August 1995
End date: August 1999

Resources

Project Engineer:
Patrick Price
AFRL/MLMS
(937) 904-4352

Contractor:
Oregon State University

JDMTP Subpanel:
Manufacturing and Engineering Systems

Parts Obsolescence Management Tool for Out Production Parts

Contract Number: F33615-98-C-5129 **ALOG Number: 1888**

Statement of Need

Obsolescence problems have become systemic and chronic in military as well as commercial systems. The Engineering Manufacturing Development (EMD) stage of some weapon systems can take five or more years. Production phases are stretched out over several more years and the actual mission life extends over decades. For example, the operational life of the B-52 is now projected to be over 90 years. Given that the typical product life cycles of most electronic components today are anywhere between 18 months to 4 years, most defense systems will have obsolescence problems before fielding, and certainly experience obsolescence during service life. Appropriate design technologies and methodologies are critical to effectively address this problem.

Approach

TRW is under a three-year contract for two Electronics Design Automation (EDA) tools. The goals of the program are to address Electronics Obsolescence problems proactively in design, by developing tools that support a Pre-Planned Periodic Improvement (P^4I) strategy. That is, we must design products from the beginning with the expectation that they will be reengineered several times over their life cycle. The objective then is to develop methodologies and tools that allow for very rapid and efficient design and redesign of electronics. TRW and it's subcontractors will address these goals by developing tools in the areas of behavioral synthesis and test vector generation. The Behavioral Product Re-engineering Tool (BPR) will be developed by Synopsys. The BPR will be based upon their VHDL behavioral synthesis CAD environment (Behavioral Compiler) and will be integrated with the Synopsys Design Environment (SDE). The BPR tool will synthesize RTL and VITAL level simulation models directly from the System Level Description Level (SLDL). A Design Verification Test Generation Tool (DVTG) will be developed by the University of Cincinnati and will be commercialized by EDAptive Computing, Inc. The tool will partially automate the test development process by generating test vectors for WAVES VHDL Test Benches from formal product requirement specification in SLDL.

Benefits

Benefits include: the ability to efficiently re-engineer an existing design to replace a part; the ability to efficiently re-engineer an existing design to replace a system; the ability to incorporate new and /or modified functions to a product; and the ability to design products from the beginning to minimize the impacts of obsolescence.

Status

Active
Start date: August 1998
End date: August 2000

Resources

Project Engineer:
George Orzel
AFRL/MLMS
(937) 904-4338

Contractor:
TRW Incorporated

JDMTP Subpanel:
Manufacturing and Engineering Systems

Parts Obsolescence Management Tools

Contract Number: F33615-98-C-5147 **ALOG Number: 1890**

Statement of Need

The lack of growth in the DOD budget for new programs presents a major challenge in sustaining and extending the service life of existing systems. Electronic parts obsolescence will have an even greater impact over time in legacy systems. Discontinued mature technology, shortened component and material life cycles, and military component supplier base reductions are three of the key factors that have required the DoD and defense contractors to identify obsolescence management as a critical element within the system life cycle planning process. The two critical key components for a parts obsolescence management process, namely effective automated tools and best practice methodologies, were unavailable to arrive at a best value solution. The objective of the program is to develop an add-on module to an existing commercial product and adapt it for use by Air Force program offices and maintenance activities.

Approach

Aspect Development has teamed with Raytheon Systems Company to develop and implement the following threefold approach. First, all of the relevant obsolescence data and associated information (market trend information, component information, etc.) must be collected and readily searchable and accessible. This will be accomplished by building upon Aspect's Explore™ and VIP Reference Databases. Second, tools must be obtained for analyzing the data and developing plans based on the results of the analysis. Third, the organization must respond to the plans and associated analysis. The key elements of the solution are best practice methodology, data content, software tools, integration to legacy systems, and a process automation tool that tightly integrates these solution components. The solution will provide techniques such as graphical analysis and obsolescence reporting to enable more informed decision-making. This solution will provide the user a means to determine the most cost-effective engineering and manufacturing approach to the parts obsolescence management problem.

Benefits

Low risk approach to enabling cost-effective analysis and approaches for the management of electronic parts obsolescence for both new and existing systems. Leveraging of commercially available tools and data content whenever possible. For example, Aspect licenses data from DERA (Defense Evaluation Research Agency). The DERA life cycle data was selected because it was developed over many years combining expertise in parts obsolescence, supplier information, and additional sources of obsolescence data sets (GIDEP, WWW sites, etc.). Additionally, the team leverages integration to third party software and legacy systems whenever possible. To facilitate these integrations Aspect has formed partnerships with numerous ERP, MRP, PDM, and CAD suppliers such as SAP, Oracle, Baan and Metaphase. The combination of Aspect's experience in the component supplier management (CSM) space combined with Raytheon's knowledge of military defense systems, logistics and obsolescence management, mitigates much of the risk associated with the development of this solution.

Status

Active
Start date: February 1999
End date: January 2001

Resources

Project Engineer:
Theodore Finnessy
AFRL/MLMS
(937) 904-4344

Contractor:
Aspect Development Incorporated

JDMTP Subpanel:
Manufacturing and Engineering Systems

Predictive Activity-Based Cost Modeling Agent Network

Contract Number: F33615-99-C-5900 **ALOG Number: 2563**

Statement of Need

The result of this Phase II effort is expected to provide the engineering and technical cost estimating communities with a first order prototype tool to evaluate their designs based on advanced costing methodologies. By incorporating the use of agents, the engineer will be shielded from much of the activity necessary to make this process work, thus making this a tool that, when fully developed, can be used in a production environment.

Approach

Cognition will expand and use the ABC cost model developed in the Phase I effort while understanding that the true impact of this effort can be applied to any costing methodology, not just ABC. Cognition will demonstrate: 1) an expanded ABC cost model developed in Phase I to more fully demonstrate the predictive cost capabilities of the total program; 2) an agent assisted environment where users can take advantage of complicated data networks without prior knowledge of location and access to the data; 3) demonstrate capabilities of an agent assisted network for maintaining the fidelity of cost estimates by keeping the user informed of data changes which directly affect the specific cost session.

Benefits

Integration of the costing function has shown the capability to greatly reduce the time required to identify changes within the manufacturing process which effect cost and producibility, and to provide that information in a timely manner to the people who most need it.

Status

Active
Start date: March 1999
End date: February 2001

Resources

Project Engineer:
Cliff Stogdill
AFRL/MLMS
(937) 904-4350

SBIR Funded

Contractor:
Cognition Corporation

JDMTP Subpanel:
Manufacturing and Engineering Systems

RASSP Approach to Legacy Electronics

Contract Number: F33615-98-C-5130 **ALOG Number: 1891**

Statement of Need

The lack of growth in the DOD budget for new programs presents a major challenge in sustaining and extending the service life of existing systems. Electronic parts obsolescence will have an even greater impact over time in legacy systems. Discontinued mature technology, shortened component and material life cycles, and military component supplier base reductions are three of the key factors that have required the DoD and defense contractors to identify obsolescence management as a critical element within the system life cycle planning process. The two critical key components for a parts obsolescence management process, namely effective automated tools and best practice methodologies, were unavailable to arrive at a best value solution. The objective of the program is to develop an add-on module to an existing commercial product and adapt it for use by Air Force program offices and maintenance activities.

Approach

This effort will identify a set of legacy components, and using an automated model generator from a library to be accessed by exiting synthesis tools. Both synthesizable and simulatable versions will be developed in VHDL format. The model library and tools will form an integrated framework for this proposed RALE environment.

Benefits

The use of executable requirements, specifications and virtual prototypes will reduce the time required to design and field a working prototype electronic systems. It also enables design captive in a form that promotes enhancements to form, fit, and function characteristics of all mods updates to existing systems.

Status

Active
Start date: June 1998
End date: November 2000

Resources

Project Engineer:
Theodore Finnessy
AFRL/MLMS
(937) 904-4344

Contractor:
VP Technologies

JDMTP Subpanel:
Manufacturing and Engineering Systems

Responsible Agents for Product/Process Integrated Development

Contract Number: F33615-96-C-5511 **ALOG Number: 1447**

Statement of Need

A designer sought to embed a set of functions (e.g., optical, electromechanical, control) in an artifact with specified characteristics (e.g., weight, color, complexity, materials, power consumption, physical size). The functional view drives most designs, since it distinguishes the disciplines in which engineers are trained and in support of which design tools are available. Conflicts arise when different teams disagree on the relation between the characteristics of their own functional pieces and the characteristics of the entire product. Some conflicts are within the design team. Responsible Agents for Product-Process Interactive Design (RAPPID) is a community of agents (active software objects with varying degrees of intelligence) that help human designers manage product characteristics across different functions and stages in the product life cycle. Agents represent not only design tools and humans with a stake in the design (including designers, manufacturing engineers, and marketing and support staff), but also the components of the design itself, and the characteristic of each component. These agents trade with one another for design constraints, requirements, and manufacturing alternatives, and the resulting marketplace provides a self-organizing dynamic that yields more rational designs faster than conventional techniques.

Approach

The contractor:

- Identified relevant design characteristics, design process information design data flows, and characteristics for buy-and-sell prices, and provided a KIF/KQML compatible shared data repository for this information.
- Identified and implemented corresponding software information agents.
- Selected an appropriate object-based development environment.
- Developed a suitable client-server environment periodically throughout its development.
- Transitioned RAPPID technologies to other Manufacturing Automation and Design Engineering (MADE) contractors.

The second version RAPPID software was released in June 1997. This software includes a complete JAVA client to serve as the interface to the human agent for collecting market bid data and presenting the market data in tabular and graphical formats. Training is ongoing with Army TACOM engineers. TACOM is providing the Future Infantry Vehicle as a design testbed for the RAPPID system.

Benefits

The RAPPID environment enhances a design team's ability to more thoroughly explore a product's design space, thus allowing for better optimized designs and shorter design cycle times.

Status

Complete
Start date: March 1996
End date: March 1999

Resources

Project Engineer:
James Poindexter
AFRL/MLMS
(937) 904-4351

DARPA Funded

Contractor:
Industrial Technology Institute

JDMTP Subpanel:
Manufacturing and Engineering Systems

Robust Design Computational System

Cooperative Agreement Number: F33615-96-2-5618 ALOG Number: 1477

Statement of Need

The deterministic analysis used in the current design environment provides no quantitative values of risk, reliability, or projected failure rates. Quantifying risk requires numerically accounting for variabilities and uncertainties which is not currently done. Typical design practices employ a deterministic analysis of a particular design point using some combination of typical and worst case design parameters. Fabrication process variations are frequently ignored or again approached by evaluating a projected "worst case." In current practice, risk is typically quoted as a "factor of safety" using some "worst case" scenario. Sensitivity of the risk to the variabilities is generally unknown except for a few chosen parameters. Reliability numbers are based on historical experience, but generally the only reliability recognized is that derived empirically from expensive development testing. The current unavailability of the computation infrastructure and tools coupled with the lack of quantitative linkages between design and production prevent assembling a seamless numerical multidisciplinary system model. This results in only certain aspects of the design being examined in detail within a single disciple while the importance of variables at the system level are likely to be unknown. Thus, the system level interactions of the components are discovered in the test phase of the program when problems are very costly to correct. The objective of this effort is to develop and demonstrate engineering tools and information integration capabilities that could be used to evaluate more design alternatives than is possible today.

Approach

The approach will build infrastructure and software tools for a robust design computational system (RDCS). It will also provide the Integrated Product and Process Development (IPPD) team improved ability to: a) explore, generate, store, and analyze design alternatives, b) numerically account for the effects of "downstream" variability, c) quantify risk, reliability, and sensitivities using probabilistic analysis methodologies, and d) optimize designs for selected performance parameters such as costs, weight, or life.

Benefits

The RDCS will develop tools and infrastructure to support the design engineer in rapidly exploring, generating, tracking, storing, and analyzing design alternatives. The design engineer will be able to begin with a parametric design representation, assemble a series of functional modules from multiple disciplines to simulate product and processes, efficiently evaluate the design options using distributed and parallel processing, invoke a variety of design sensitivity and optimization options, and effectively analyze the results to enable an informed design decision.

Status

Active
Start date: June 1996
End date: December 1999

Resources

Project Engineer:
Daniel Lewallen
AFRL/MLMS
(937) 904-4343

DARPA Funded

Contractor:
Rockwell International

JDMTP Subpanel:
Manufacturing and Engineering Systems

Simulation Assessment Validation Environment

Contract Number: F33615-95-C-5538 **ALOG Number: 1336**

Statement of Need

Military aircraft manufacturing does not enjoy the traditional cost benefits of mass production because large quantities are not usually required. Separating low cost from high volume requires new approaches to product and process design and technology maturation. Virtual Manufacturing (VM) supports this concept by applying modeling and simulation technology to prove out and select optimal new concepts. The "Simulation Assessment Validation Environments" (SAVE) program is a first step in realizing the near-term objectives common to VM and the Joint Strike Fighter (JSF) program. The objective of SAVE is to implement, demonstrate, and validate integrated modeling and simulation tools and methods used to assess the impacts of product/process decisions on the affordability of advanced strike warfare technology.

Approach

The effort focused on initial implementations of VM strategically applied to specific real fighter or attack aircraft design and production affordability problems. The SAVE program consisted of two phases. The goal of the Phase I demonstration was to take the user through a complete manufacturing scenario and communicate the functional capabilities of the developed tools. The Phase I demonstration validated the core VM capabilities, identified performance and business metrics against real production problems associated with a redesign of the F-16 horizontal stabilizer, and pointed to areas for continued refinement/enhancement to be accomplished during the second phase of the program. The Phase II effort targeted ongoing weapon system mechanical component or subassembly applications, specifically the redesign of the F-22 gunport assembly. Phase II culminated with a full demonstration of the developed VM capabilities applied to the F-22 weapons bay door assembly. This program successfully demonstrated the latest version of the SAVE data model and integration environment. This version is based on a Common Object Request Broker Architecture (CORBA) approach. In addition, a flexible web-based data model editor/browser was demonstrated which allows design team members to view and update information within the SAVE data model directly. Capabilities integrated into the SAVE environment for this demonstration include: component design, tool design, tolerance analysis, assembly planning, ergonomic assessment, factory floor simulation, risk assessment, and cost analysis.

Benefits

- Affordability — Increased reliability of cost and process capability information.
- Quality — More producible designs with higher quality work instructions and fewer engineering changes.
- Producibility — Trouble-free, high-quality, first article production, involving no rework and fully meeting customer requirements.
- Flexibility — Rapid product changeovers, ability to mix production of different products, and quick return to producing previously shelved products.
- Shorter Cycle Times — Direct production without false starts.
- Responsiveness — Quicker response to customer's questions.
- Customer Relations — Improved relations through increased customer participation in the IPPD process.

Status

Active
Start date: April 1995
End date: December 1999

Resources

Project Engineer:
James Poindexter
AFRL/MLMS
(937) 904-4351

JSF Funded

Contractor:
Lockheed Martin Aeronautical Systems Corporation

JDMTP Subpanel:
Manufacturing and Engineering Systems

Supply Chain Integrated Product/Process Development Pilot Project (SCIP)

Cooperative Agreement Number: F33615-96-2-5602 ALOG Number: 1472

Statement of Need

It has long been recognized that there are large costs and substantial delays incurred by suppliers (ultimately passed along to their customers) due to inefficiencies in the movement of product information in the supply chain. Some of these costs are incurred due to technical problems, such as the need to translate product data when it is exchanged between CAD systems. Other costs are incurred because of miscommunication and because business processes are misaligned among members of the chain.

Approach

The pilot addressed these problems by piloting solutions in real-life settings and developing a guide and business case for those solutions. This means that both new technologies and new business practices will be tried in real automotive supply chains as they develop real parts. For this to be successful, the technologies have to be commercially available and the business practices have to be tried and proven. The primary technology is the STandard for the Exchange of Product model data (STEP), the new product data exchange standard, formally known as ISO 10303. The business processes addressed were those related to Integrated Product/Process Development (IPPD) which enable the supply chains to take advantage of STEP, resulting in significant improvements in performance. Business process activities were undertaken in five commercial automotive supply chains and two military tracked vehicle chains. The five major activities include: As-Is Assessment; Benchmarking; Pilot Planning; Pilot Implementation; and Evaluation and Dissemination.

Benefits

- Improved and more cost effective IPPD across the entire supply chain
- Cost effective reuse of original CAD Data for:
  Engineering analysis (e.g., finite element analysis)
  Rapid prototyping (e.g., stereo lithography)
  Virtual prototyping (digital mockup)
  Tooling design (packaging and digital preassembly)
  CNC programming and cutter path verification
  Documentation (e.g., service manuals)
- Documented business case for the use of STEP technology
- Clear and well documented path to deployment

Status

Complete
Start date: December 1995
End date: March 1999
Final Report No.
AFRL-ML-WP-TR-1998-4098

Resources

Project Engineer:
George Orzel
AFRL/MLMS
(937) 904-4338

DARPA Funded

Contractor:
Automotive Industry Action Group (AIAG)

JDMTP Subpanel:
Manufacturing and Engineering Systems

Systems Engineering Using Key Characteristics

Contract Number: F33615-98-C-5158 **ALOG Number: 1934**

Statement of Need

The objective of this project is to reduce the learning curve associated with the start of assembly by identifying and managing critical issues early in the product development cycle. The contractor will develop an Internet based tool to enable the identification, propagation, and change management of Key Characteristics (KCs) throughout an enterprise. KC can be defined as product features, manufacturing process parameters, and assembly process issues that significantly affect product performance, function, and form. They are classified into three different types of engineering functions: 1) Product Key Characteristics (PKCs), which are product geometric features and material properties that have a significant impact on the product performance function and form at each product assembly level; 2) Assembly Process Key Characteristics (AKCs), which are the features during each assembly stage of the product tool fixture or procedures that significantly affect the assembly process; and 3) Manufacturing Process Key Characteristics (MKCs), which are the manufacturing machine process parameters and/or work piece fixturing features for machine tools and equipment that significantly affect the realization of a product.

Approach

The system will use an Active Constraint Network architecture that is integrated with host applications such as CAD/CAM Systems, Process Capability Databases, and Spreadsheets.

Benefits

The development of the tools and methods for systems engineering using Key Characteristics will reduce the learning curve associated with the start of assembly by identifying critical issues early in the product development cycle. Furthermore, the assessment of manufacturing cost trade-offs during product development can be better performed by considering engineering issues, manufacturing issues, and customer requirements. By identifying the critical product features up front, resources can be allocated to address them through multi-disciplinary teams.

Status

Active
Start date: September 1998
End date: March 2000

Resources

Project Engineer:
George Orzel
AFRL/MLMS
(937) 904-4338

Contractor:
Schwalb Consulting

JDMTP Subpanel:
Manufacturing and Engineering Systems

Weapon System-Integrated Cost Estimating Model (CEM): An Automated Methodology

Contract Number: F33615-99-C-5905 **ALOG Number: 2385**

Statement of Need

The Air Force Manufacturing Technology Division, in conjunction with the F-22 System Program Office (SPO), is interested in the establishment of a methodology that supports weapon systems cost management considering cost as an independent variable throughout the total life cycle. The core of this methodology must be generic weapon systems based cost models, tailorable and flexible enough to be accessed by tools and techniques used by industry. The objective of this project is to develop a weapon systems cost methodology for predictive decision weapon system cost analysis and support.

Approach

A Weapon System-Integrated Cost Model (WS-ICM) framework of integrated cost architectures will be developed for major life cycle cost categories (3600, 3010, 3400) of a weapon system by control level, within and among prime and subcontractors. The WS-ICM and its component cost architectures must be designed, constructed, populated, validated and demonstrated to cost experts and program managers from across industry and government. Extensive consideration must be given to building on standards-based approaches with compatible historical data interfaces enabling use (for example) of R&D, mods, spares, sustainment, prior best business practices, infrastructure, labor, learning curve data and realization cost factors, etc. The contractors will create a WS-ICM framework to launch detailed work on the contractor specific cost model targets, tools and integration strategy (i.e., the life-cycle Cost Estimating Model or Air Force total ownership cost as the Operational and Support Model). A Production Cost Model (PCM) is currently being developed for demonstration and will be shared for integration with the contractor. In the integrated WS-ICM demonstration, containing models produced by different organizations, the user will see a single and consistent view of the data, while being networked, using dissimilar computers, geographically separated, and operating in a secured (as required) repository mutually available for use by government and industry teams supporting WS-ICM and individual WS cost models. The F-22 SPO and FM will participate in the technical evaluation and reviews in all phases of this project with anticipation of potential use of high quality successful automated results.

Benefits

This SBIR Phase II will refine the affordability methodology, data and models prototyped and demonstrated in Phase I for cost estimating. This work will consider cost as an independent variable (CAIV) over the life cycle of new weapon systems acquisitions, mods and updates based on performance and operational requirements. The CEM will be capable of operating as a stand-alone capability or as a functional component of the WS-ICM.

Status

Active
Start date: May 1999
End date: September 2001

Resources

Project Engineer:
David Judson
AFRL/MLMS
(937) 904-4590

SBIR Funded

Contractor:
Frontier Technology Incorporated

JDMTP Subpanel:
Manufacturing and Engineering Systems

Weapon System-Integrated Cost Model (WS-ICM) Production Cost Model (PCM)

Contract Number: F33615-98-C-5137 **ALOG Number: 1673**

Statement of Need

The Manufacturing Technology Directorate aggressively pursues advances in manufacturing technology which have broad applicability to the affordability and performance of Air Force systems. The focus of this general topic is to allow opportunities for major breakthroughs in the following areas: Composites Processing & Fabrication, Electronics Processing & Fabrication, Metals Processing & Fabrication, Advanced Industrial Practices, and Manufacturing & Engineering systems. New processing techniques, variability reduction tools, affordability improvements, manufacturing simulation and modeling, are a few examples of the types of proposals that are desired. The emphasis is on innovation, the ability to achieve major advances, and defense/commercial applicability. The primary objective of this project is to create the generic core of a computer-based production cost model to support systems program offices in the attainment of several acquisition reform initiatives. The PCM supports the information requirement of costs as an independent variable (CAIV), including aggressive cost goals, trade-off analyses, and incentive measurements.

Approach

This SBIR Phase II program will build and validate the generic product cost model (PCM). The PCM will be installed in beta sites, and on a production program, after validation by the contractor. The PCM will provide management with a cost management decision support tool to determine the affordability of on-going production and a cost control for manufacturing in a predictive approach, rather than reactive.

Benefits

Benefits include both in identifiable savings in software development and the quality of information made available for management decision making.

Status

Active
Start date: May 1998
End date: September 2000

Resources

Project Engineer:
David Judson
AFRL/MLMS
(937) 904-4590

SBIR Funded

Contractor:
Wallace & Company

JDMTP Subpanel:
Manufacturing and Engineering Systems

Web-Based Collaborative Cost Analysis Warfighting Power By Fighting Hour

Contract Number: F33615-99-C-5904 **ALOG Number: 2565**

Statement of Need

This multi PEO supported Phase I SBIR will define the affordability methodology for this WEB-based Warfighting Power by the Fighting Hour (WPFH) application, data and models. The WPFH will be capable of using the Weapon System-Integrated Cost Model (WS-ICM) common data base. The WPFH prototype will be demonstrated in Phase I for specific time span analysis and life cycle per flying hour estimates and actual cost based on Operation and Support data available from AFTOC, CORE and other cost databases. This work will consider cost as an independent variable (CAIV) over the life cycle of new weapon systems acquisitions, currently operating weapons systems, mods and updates based on performance and operational requirements.

Approach

The contractor will use a systems engineering using an iterative spiral methodology approach to collect synthesis and validate customer needs and technical requirements to resolve those needs. A prototype will then be developed and reviewed by the assembled Technical Review Board (TRB). This will ensure that the integrated life cycle strategy is accomplished to enable consideration of periodic time dependent and complete analysis and reporting to be accomplished. TRB involvement will also ensure that the WEB-based Warfighting Power by the Fighting Hour (WPFH) architecture, applications and infrastructure meet the needs of the users and can be integrated into the supported WS-ICM framework of cost management tools. The approach will be supported continuously by a living program master plan and schedule (PMPS). The contractor will develop the WPFH tools within scope and funding constraints, demonstrate and validate WPFH prototype to potential Phase II beta sites for commitment. WPFH will be demonstrated in the stand-alone and WS-ICM integrated modes.

Benefits

The benefits of this technology when operational is to demonstrate the value of using historical data by weapon system class to predict the cost of a system performance and to analyze actual cost by weapon system as it is performing to determine costs analysis of system performance, sustainment, repair, impact of use and age, requirements for upgrades, etc.

Status

Active
Start date: April 1999
End date: January 2000

Resources

Project Engineer:
David Judson
AFRL/MLMS
(937) 904-4590

SBIR Funded

Contractor:
Frontier Technology Incorporated

JDMTP Subpanel:
Manufacturing and Engineering Systems

A Non-Invasive Vibration Sensor for the Machine Shop

Contract Number: F33615-99-C-5312 **ALOG Number: 2561**

Statement of Need

Machine tool vibrations induce a number of difficulties including poor surface finish, reduced dimensional accuracy, and damage to the machine tool itself. Present day production machine tools control vibrations by optimizing characteristics of the structure and by adjusting process throughput, resulting in overly conservative metal removal rates.

Approach

During this Phase I SBIR a prototype system will be designed, fabricated and tested. The testing will be performed both in the laboratory and in an operating machine shop.

Benefits

Development of the laser vibrometer will provide measurement and machine tool control for both government and commercial applications. The developed device will provide a substantial new capability in performing diagnostics and automated feed control for sophisticated machine tools.

Status

Complete
Start date: April 1999
End date: September 1999

Resources

Project Engineer:
Rafael Reed
AFRL/MLMP
(937) 904-4393

SBIR Funded

Contractor:
A2Z Technologies Corporation

JDMTP Subpanel:
Metals

Advanced Reconfigurable Machine for Flexible Fabrication

Contract Number: F33615-95-C-5500 **ALOG Number: 1352**

Statement of Need

One of the common problems plaguing the manufacturing process is excessive vibration of the cutting tool. This vibration is influenced by several factors including tooling, part fixturing, and machine structural dynamics. This project addressed the machine structural portion of the problem by offering a machine configuration that is anticipated to be six times as stiff as conventional orthogonal axis machine tools with a first mode resonant frequency in the range of 200 Hz. It developed a 21st century machine tool, the enhanced Octahedral Hexapod, which provides revolutionary advances in flexible fabrication technology. The objectives of this effort were to: develop a reconfigurable machine for flexible fabrication of critical military components; demonstrate high throughput, high precision, low cost production of aerospace components; transition technology to spacecraft and robotic vibration control and precision position; and introduce advanced materials technology into the U.S. machine tool industry.

Metals

Approach

The technical approach for this project is based on state-of-the-art analytical models for structural dynamics, tool-workpiece interaction, and control simulation to enhance accuracy by minimizing vibration and machine distortion.

These models drive the incorporation of:

- Applying active vibration cancellation devices.
- Reducing the mass and increasing the stiffness of machining arms, spindles, and structural components.
- Exploiting near-zero coefficient of thermal expansion composites.

Benefits

The benefits include:

- A machine tool capability of $\pm$ 2 μm accuracy, $\pm$ 1 μm repeatability, and a 75 percent increase in metal removal rate.
- Ability to machine small or large lots of critical components with equal precision, flexibility, and cost.

Status

Active
Start date: April 1995
End date: September 2000

Resources

Project Engineer:
Deborah Kennedy
AFRL/MLMP
(937) 904-4392

DARPA Funded

Contractor:
Lockheed Martin Corp.

JDMTP Subpanel:
Metals

Affordable, Improved Plastic Patterns for Precision Investment

Contract Number: F33615-98-C-5145 **ALOG Number: 1973**

Statement of Need

The objective of this project was to investigate and develop an affordable injectable plastic for pattern making of investment cast jet engine components. The contractor proved feasibility and potential advantages of new materials and processing methods by the use of analytical tools such as simulation and modeling to predict the flow characteristics of selected plastic into dies of varied shapes, size, and complexity. Emphasis was placed on an affordable approach to minimize the cost of the die as well as the pattern making process, including preliminary assessment of the anticipated cost savings/avoidance of new plastic composition.

Approach

Over 200 test samples were prepared with various permutations of formulations of plastic materials. The plastics were evaluated for many different properties, including percent ash content, flexural strength and modulus, thermal expansion, moldability for fine details, and shrinkage. UDC methodically selected and screened many different polymers, fillers, stabilizers, and catalysts. A number of the plastic pattern samples were submitted to Howmet for testing their suitability in an actual foundry environment. Howmet performed their tests on the plastic patterns, which included ash content, thermal expansion, monoshell compatibility, and facecoat adhesion. In the final tests at Howmet, four of the six molds survived the shell burnout cycle in perfect condition. All of the formulations had negligible ash content; acceptable for investment casting. Future modifications of the plastic formulations will need to be investigated for both jet engine components and airframe parts, but it appears that the current formulation will require only minor improvements during a Phase II SBIR to make them suitable for engine and airframe pattern material for investment casting.

Benefits

The developed plastic has better "burn-out" characteristics than currently used pattern materials and will be readily moldable for fine details and good die fill.

Status

Complete
Start date: April 1998
End date: October 1998

Resources

Project Engineer:
Siamack Mazdiyasni
AFRL/MLMP
(937) 255-2413

SBIR Funded

Contractor:
Utility Development Corporation

JDMTP Subpanel:
Metals

Affordable, Improved Plastic Patterns for Precision Investment

Contract Number: F33615-99-C-5305 **ALOG Number: 2476**

Statement of Need

This program will make a significant contribution towards cost/performance improvements in precision investment cast components. The objective is to optimize the plastic pattern materials that were developed and tested during the Phase I program. The Phase II research will result in an increase in the strength and modulus so that these plastics will be suitable for large castings and very thin castings with large surface areas.

Approach

The contractor will perform the following: 1) increase flexural strength and modulus to at least five times higher than currently used wax; 2) reduce the cure time of the plastic formulations; 3) evaluate bonding of plastic sections together; 4) establish repairability of plastic patterns; 5) reduce residual ash content to below 0.1 percent; 6) comprehensive evaluations and testing on molding cycle details, physical properties, dimensional stability, flowability, trace element analysis, burnout cycle, ash content and surface finish quality; 7) perform improvements and benefits evaluation; and 8) prepare specification for materials and processing/molding procedures.

Benefits

The plastic pattern materials will provide lower cost and higher quality components and will be beneficial to all industries ranging from aerospace to automotive/transportation to medical.

Metals

Status

Active
Start date: March 1999
End date: January 2001

Resources

Project Engineer:
David See
AFRL/MLMP
(937) 904-4387

SBIR Funded

Contractor:
Utility Development Corporation

JDMTP Subpanel:
Metals

Cell for Integrated Manufacturing Protocols, Architectures and Logistics

Contract Number: F33615-90-C-5003 **ALOG Number: 89**

Statement of Need

There is an ever-increasing need to educate and train industry, particularly small manufacturers, and academia in emerging technologies for advanced manufacturing. The objective of this project was to establish an integrated flexible manufacturing cell for use as a laboratory for students, faculty, and small aerospace manufacturers. It was employed as a demonstration site for networking and other technologies. Demonstrations were primarily aimed at subcontractors.

Approach

This program established a test bed to demonstrate technology involved in a small computer integrated workcell. Robots, machine tools, and computers were networked using Manufacturing Automation Protocol or other protocols. Shop floor control, MRP II and other software were integrated into the cell. Manufacturing engineering students and small aerospace subcontractors became acquainted with the new computer integrated manufacturing technologies associated with the cell.

Benefits

Implementation of the cell provided faculty and students with an invaluable educational tool, as well as provided a research vehicle. In addition, Air Force Research Laboratory's Materials and Manufacturing Directorate benefited by using the cell as a test bed and demonstration site for protocols and other technologies that are fostered by the Air Force and the Department of Defense. Central State University demonstrated these technologies to aerospace subcontractors. This capability will be a positive addition to the resources available in the Dayton area.

Status

Complete
Start date: July 1990
End date: June 1999

Resources

Project Engineer:
David See
AFRL/MLMP
(937) 904-4387

Contractor:
Central State University

JDMTP Subpanel:
Metals

Demonstration of the Manufacture of Lattice Block Materials as a Solid

Contract Number: F33615-98-C-5146 **ALOG Number: 1754**

Statement of Need

JAMCORP is demonstrating the manufacture of lattice block material (LBM) as a solid freeform fabrication technique. JAMCORP is using sand casting to make very large sections of an airframe (e.g. an entire wing section) as single castings, eliminating the need for machining and assembly. There are three primary objectives for this Phase I effort: to demonstrate the cost effective manufacturing of a non-trivial number of identical components to ISO9000 standards with reduced tooling costs and reduced piece process compared to carbon fiber lay-up using LBM; to quantify the full potential, accounting for both the physical and financial performance, of using LBM technology in Air Force and other military systems; and to determine the steps necessary to insert LBM technologies into the existing manufacturing programs or into future programs.

Approach

A significant number of components will be fabricated using the contractor's patented Lattice Block Material technology. The component design will be agreed to by the Air Force and contractor before fabrication begins. These components will then be tested against their conventionally manufactured counterparts to determine improved material performance as well as the reliability of the LBM manufacturing process.

Benefits

JAMCORP successfully demonstrated the manufacture of lattice block material (LBM) as a solid freeform fabrication technique using sand casting to make very large wing-like sections of an airframe as single castings, eliminating the need for machining and assembly. Analysis of scaling-up the casting process for larger sections of an airframe, cost comparisons, and shell core tooling design were completed.

Status

Complete
Start date: May 1998
End date: November 1998

Resources

Project Engineer:
Laura Leising
AFRL/MLMP
(937) 904-4388

SBIR Funded

Contractor:
Jonathan Aerospace Materials Corporation (JAMCORP)

JDMTP Subpanel:
Metals

Engine Supplier Base Initiative

Cooperative Agreement Number: F33615-95-2-5555 ALOG Number: 1265

Statement of Need

Until recently, the industry's technological base was sustained and dominated by the drive to maintain the United States' military edge. With reduced defense spending in the United States, engine designers, material developers, and manufacturing engineers must confront a new challenge. In the past, performance at any cost was the military rule. However, the future of the gas turbine engine industry will be based not only on performance, but affordability as well. A need exists to establish a national initiative to address the affordability of gas turbine engines by attacking the high cost areas known to exist. This program is aimed at providing more affordable propulsion by identifying and attacking high cost manufacturing processes and business practices within the military engine supplier base community.

Approach

This effort addresses the affordability of gas turbine engines by effectively coupling advanced technology tools, new business practices and policies, and lean principles. The majority of the manufacturing related to this particular sector is conducted at the supplier base. This effort is being lead by the investment casting supplier base community with the engine manufacturers as team members defining the requirements. The focus of this initiative is on investment casting of complex nickel-base superalloy and titanium-base airfoil and large structural castings for man-rated gas turbine engines. Emphasis is on reducing lead times for prototype and production castings, significant reduction in rework of structural castings, reduction in scrappage rates of airfoils, and elimination of redundant specifications. Metrics are measured through major component demonstrations for military engines. The effort is structured to consist of three phases. Phase I, Concept Phase, consists of qualitative benchmarking of the "as-is" process, and identification of key tasks for "proof of concept" demonstration and validation. The Concept Phase includes an implementation/transition plan to ensure low risk entry of the technology and tools into production. Phase II, Demonstration and Validation Phase, demonstrates and validates the tools and practices identified in the Concept Phase. Phase III, Production Transition Phase, incorporates successful technologies into a production run and measures the improvements against the baseline.

Benefits

This effort will enable the United States to maintain its technological superiority in the gas turbine engine business while providing for affordable propulsion for future systems. The goals of the program are: to achieve a 50 percent improvement in quality as related to structural rework, airfoil tolerance, and single crystal scrap; to achieve a 25-50 percent improvement in cycle as related to production cycle time, tooling procurement, and new part design and process development time; and to build stable and cooperative relationships internally and externally, to implement cultural change in an interorganizational environment. Cost avoidance estimated in excess of $25 million has been achieved as a result of the technical activities. The program's progress is in excess of the stated targets.

Status

Active
Start date: September 1995
End date: August 2001

Resources

Project Engineer:
Dr. Rollie Dutton
AFRL/MLMP
(937) 904-4389

Air Force Funded

Contractor:
Howmet Corporation

JDMTP Subpanel:
Metals

Lean Blade Repair Pilot

Contract Number: F33615-93-C-4301 **ALOG Number: 314**

Statement of Need

Stringent mission requirements have resulted in engine manufacturers using advanced superalloys (e.g., directionally solidified (DS) and single crystal (SC) in novel airfoil configurations). These advanced alloys typically have limited weldability. The current repair techniques consist of rebuilding worn blades primarily through manual welding operations. Current manual repair methods do not have the repeatability to produce a cost-effective repair. A flexible, automated welding machine (FAWM) will meet the requirements to weld repair blades currently being repaired as well as projected future blade repair requirements. The objective of this program was to establish advanced manufacturing technology for cost-effective semi-to-automatic repair processes for selected Air Force high performance gas-turbine engine components. These technologies were installed at Oklahoma City Air Logistics Center (OC-ALC). This effort involved selecting the most efficient and cost-effective process between laser and pulsed-arc welding technologies. These two processes have proven to provide excellent weld properties on a laboratory scale, but have not been used in production.

Metals

Approach

The goal of this Air Force Manufacturing Technology program was to demonstrate advanced manufacturing concepts and technology to improve the quality and reduce the repair cycle time of Air Force high performance gas turbine engine components in the Blade Repair Facility at Oklahoma City Air Logistics Center. The goal was the incorporation of three efforts: to provide process optimization design and analyses to the Propulsion Production Division in implementing advanced manufacturing concepts and practices in the improvement of the operation of the Blade Repair Facility; to construct a computer model of the jet engine overhaul and repair process; and to develop, validate, and install an automatic tracking system for in-process turbine blades. The program used the information developed by previous modeling as well as manufacturing practices and principles used in industry. Where possible, improvement actions were implemented immediately but where necessary, improvement actions requiring the purchase, and/or installation of additional equipment will be implemented later. Throughout the program, success was measured by improved cycle times, decreased inventory, and improved quality, resulting in improved customer responsiveness and elimination of wasted resources.

Benefits

Benefits derived from this task include: reduced scrap by 30 percent; reduced cost of blade and blade-tip overhaul; and new capability to process thin-walled hardware. The task includes an option to design, fabricate, and install the FAWM for a variety of Navy blade and vane components at Cherry Point Naval Aviation Depot. Potential cost savings is about $24 million over two years. This only accounts for three engines; there are five in the program.

Status

Complete
Start date: September 1993
End date: June 1999

Resources

Project Engineer:
Rafael Reed
AFRL/MLMP
(937) 904-4393

Air Force Funded

Contractor:
General Atomics Corporation

JDMTP Subpanel:
Metals

Manufacturing Technology for Affordable Laser Shock Peening

Contract Number: F33615-98-C-5150 **ALOG Number: 1713**

Statement of Need

To date, the primary focus for laser shock peening has been on processing turbine blades with sub-optimized equipment at low production rates. Under this program, all aspects of laser shock peening will be addressed through a systematic approach to increase workload flexibility, increase production throughput, and reduce processing cost and time while simultaneously developing the business case required to transition laser shock peening to other industry sectors. Teaming arrangements between the offeror and the user community (both aerospace and non-aerospace) is required. The overall objective of this effort is to design, develop and implement a production-capable laser shock peening manufacturing cell for applications to gas turbine engine blades and other fatigue critical components. It is anticipated that two cells will be implemented: one within a system builder's facility (to be used for follow-on development and industry sector service) and the other within an aerospace gas turbine engine manufacturer's facility.

Approach

The focus of this effort is to: a) develop a robust factory floor laser shock peening system flexible enough to accommodate various component geometries; b) incorporate advanced monitoring and control techniques to this laser system increasing process reliability and repeatability; c) incorporate automated processing subsystems to this laser system to increase throughput; d) develop and execute an effective business strategy to commercialize this laser system within and without the aerospace industry by making available laser peening manufacturing cells to those parties interested in obtaining the technology and by providing an industry capability; and e) validate this laser system's performance at an aerospace user's facility. Phase I is divided into three areas of investigation: a) design and fabricate the required laser controls and monitors promoting reliability and repeatability of the laser system process and performance; b) design and fabricate automated processing subsystems to increase the throughput of components within the manufacturing cell; and c) develop the commercialization plan to transition this technology to other applications within the aerospace community as well as applications in other industry sectors. Phase II will design, fabricate and validate two laser shock peening manufacturing cells integrating both the laser controls and monitors as well as the automated processing subsystem, with demonstrations at two locations.

Benefits

Implementation of a production-capable laser shock peening manufacturing cell will result in the decrease in shock peening cost by approximately 60 percent while increasing throughput by approximately eight times over current baseline cost.

Status

Active
Start date: August 1998
End date: February 2002

Resources

Project Engineer:
David See
AFRL/MLMP
(937) 904-4387

Contractor:
LSP Technologies Incorporated

JDMTP Subpanel:
Metals

Stretch-Forming Simulation (SFS)

Contract Number: F33615-98-C-5120 **ALOG Number: 1971**

Statement of Need

Fabrication of stretch-formed parts poses significant and current unsolved challenges to manufacturing engineers. For this reason, forming processes or required parameters for manufacturing a complex component cannot be adequately determined. Current shop floor methods of predicting manufacturing parameters rely chiefly on personal experience and some preliminary data on springback, bend allowance, lubrication, and annealing requirements. Even after extensive trial and error, the quality of the formed parts may not be acceptable because of the dimensional inaccuracies. To make these parts conform to requirements, extensive time is spent on non-valued added operations such as hand work, checking, and straightening. These will utimately increase the variability of the parts, resuling in the need for more concentrated quality control and an increase in product cost. Along with the high cost and lower quality due to variability come longer cycle times as a result of degraded process efficiency.

Approach

The program will focus on developing, integrating, demonstrating, and implementing the Stretch Forming Simulation system at OC-ALC. The software will be integrated with the Metal Forming Simulation (MFS) system and will work seamlessly with each module. The SFS software will have the capability to: perform reverse engineering; develop flat patterns from CAD 3-D data; predict any manufacturing defect prior to fabrication; optimize designs; and develop tool parameters.

Benefits

It is estimated that by developing and implementing a simulation package for stretch forming: scrap and handwork can be eliminated; non-essential labor hours can be reduced by 90 percent; cycle time can be reduced by 75 percent; throughput time can approach process time; non-value added processes and procedures can be eliminated; cost can be reduced; and manufacturing information can be accurate, timely and meaningful.

Metals

Status

Active
Start date: May 1998
End date: December 1999

Resources

Project Engineer:
Deborah Kennedy
AFRL/MLMP
(937) 904-4392

Air Force Funded

Contractor:
Northrop Grumman Corporation

JDMTP Subpanel:
Metals

Mobile Automated Scanner (MAUS)

Contract Number: F33615-91-C-5664 **ALOG Number: 1508**

Statement of Need

Nondestructive inspection of aging structures involves a difficult balance between accurate detection of potential defects, and cost-effective completion of inspection tasks within the time and budget constraints of an aircraft maintenance organization. It is often cost prohibitive to survey large sections of the aircraft for potential defects, therefore inspection techniques commonly used for aging aircraft evaluation are currently focused on small, specific areas of concern. Enhancements in nondestructive inspection technology have resulted in fast portable scanning capabilities that allow for improved flaw detection over large areas and reduced inspection costs. The Large Area Inspection of Disbonds (LARID) program addresses the rapid, nondestructive inspection of large bonded structures. This program extended the work previously completed under the Large Area Composite Inspection System (LACIS) program to enhance the Mobile Automated Scanner (MAUS III) nondestructive testing system with additional bond testing capabilities. Specific enhancements considered were pitch-catch resonance, mechanical impedance analysis, eddysonic and automated tap testing. Additional program goals included improved operator ergonomics, enhanced system durability, and reduced inspection costs.

Approach

- Baseline Mobile Automated Scanner (MAUS) unit with current Materials Division's MAUS design.
- Address production demonstration efforts required to insure unit portability, durability, maintainability, and affordability.
- Build a prototype production unit to support field implementation test validation.
- Document an implementation plan which considers training, operation and support.

Benefits

This project:

- Minimized the requirement to periodically disassemble major structural components to inspect for flaws, defects and damage.
- Significantly reduced cost and inspection time.
- Increased fleet operational readiness.
- Increased field level inspection capability.

Status

Complete
Start date: November 1996
End date: April 1999
Final Report No.
AFRL-ML-WP-TR-1999-4104

Resources

Project Engineer:
Deborah Kennedy
AFRL/MLMP
(937) 904-4392

Air Force Funded

Contractor:
McDonnell Douglas

JDMTP Subpanel:
Metals

Precision High Speed Machining With Vibration Control

Contract Number: SPO900-94-C-0010 **ALOG Number: 1261**

Statement of Need

There are three main obstacles that limit the metal removal rates of high speed machines for production of complex, flexible aerospace structures with superior quality: vibration, leading to damaged part surfaces; low feed rates and accelerations leading to excessive slow down and time spent in cornering; and limited path accuracy at higher feed rates resulting in overshoot conditions. The objective of this program was to design, develop, and demonstrate a very agile and dynamically stable High Speed, High Feed Rate, 5-Axis Machine Tool for producing extremely flexible aluminum aerospace structures with superior quality, minimum weight, and reduced part cost.

Metals

Approach

The approach was to assemble a team consisting of Boeing, Ingersoll, Setco, Lucent Technologies, Manufacturing Laboratories, Inc. (MLI), and University of Florida. This team established the performance requirements of the machine tool, designed and developed the vibration control and N/C controller technologies to be integrated onto the machine tool, fabricated and assembled the machine tool, and demonstrated its capabilities to the government and industry. Boeing was the program manager and used its experience as leader in designing high speed machined aircraft parts and as a leader in the production implementation of high speed machining to drive the specific requirements of the machine tool. Ingersoll is a leader in manufacturing high speed machines for the automotive and aerospace industries, and brought to the table its experience for designing and manufacturing a 5-axis, 1200 ipm machine tool with 2g acceleration rates. Setco, a leading U.S. manufacturer of high speed spindles, and designed and fabricated the 36,000 RPM spindle to accommodate active spindle vibration control. Lucent Technologies developed and fabricated an active spindle vibration control system to dampen out vibrations in the spindle shaft. MLI brought a wealth of experience in high speed machining technology to the table. MLI provided the chatter recognition and control system to detect and control cutter vibration, active and passive structural vibration control to minimize vibration of the machine tool, and developed the feed forward control system to maximize path accuracy at high feed rates and accelerations. The University of Florida's Machine Tool Research Center provided a test bed for evaluating the component technologies developed under this project. The machine tool was installed in Boeing's St. Louis Advanced Manufacturing Technology facility for the demonstration.

Status

Complete
Start date: May 1994
End date: September 1999

Resources

Project Engineer:
Rafael Reed
AFRL/MLMP
(937) 904-4393

DARPA Funded

Contractor:
McDonnell Douglas Corp.

JDMTP Subpanel:
Metals

Benefits

This high speed machine tool allows evaluation of leading edge vibration control and path accuracy technology for the production of complex, extremely flexible part configurations with superior quality, minimum weight and reduced part count. Industry will benefit from learning which technologies should be specified in future machine tool procurements. The government customers will subsequently benefit from increased capability to produce lightweight aerospace structures at an affordable cost.

Rapid Coater for Laser Shock Peening

Contract Number: F33615-98-C-5116 **ALOG Number: 1987**

Statement of Need

The objective of this project is to design and build an automated paint spot application and removal device and integrate with existing layer; and to investigate diffractive optics for square beam processing and integrated to existing laser system.

Approach

The design will be based on concepts demonstrated under Phase I. It will include sufficient flexibility into the device to accommodate a reasonable range of part surface geometries, i.e., curred surfaces. It will integrate control of the rapid coater system into existing layer system and will implement a process control imaging system to verify paint spot size and presence. It will also integrate diffractive optical components into the beam delivery system to provide a square beam shape.

Benefits

Implementation of the rapid coater technology will increase throughput of laser shock peened parts by 20-30 percent and decrease cost by 10 percent.

Status

Active
Start date: June 1998
End date: April 2000

Resources

Project Engineer:
David See
AFRL/MLMP
(937) 904-4387

SBIR Funded

Contractor:
LSP Technologies Incorporated

JDMTP Subpanel:
Metals

Reproducible F119 Turbine Exhaust Case (TEC) Castings

Contract Number: F33615-98-C-5160 **ALOG Number: 1781**

Statement of Need

The program was selected based on a need for the F-22 System Program Office to improve the production yield of the F119 Turbine Exhaust Case (TEC) components. Current production difficulties include variations in wall thickness of the castings, and the inability to repair defective parts in a timely and cost effective manner.

Approach

The approach will utilize thin casting integral configuration technology for the TEC to address high manufacturing costs and durability shortfalls with the current bill-of-material sheet metal design. The contractor shall: conduct preliminary casting maturation trials utilizing a flat .025 inch wall thickness iso-grid panel as the process development article; define preliminary casting process parameters, gating techniques, shell systems, and wall pinning techiques for the larger thin wall panels; establish a robust process with improved yields and repeatable wall thickness control in a production environment; investigate emerging micro-welding techniques and possible brazing repair methods for new and engine run castings as a means of improving the overall yields and the repair of engine damaged hardware; and focus the investigation on identifying casting defects (shrinkage, inclusions, hot tears, etc.) which are currently means for cast TEC hardware scrap.

Benefits

This program will result in a process that is repeatable and applicable to a number of DoD weapon systems as well as commercial applications. The new TEC utilizes thin-wall (.025 inch wall) nickel-based castings extensively throughout the design. The thin wall castings will provide a significant advantage in cost and durability, while maintaining near weight parity with the sheet metal design.

Status

Complete
Start date: July 1998
End date: October 1999

Resources

Project Engineer:
Rafael Reed
AFRL/MLMP
(937) 904-4393

Air Force Funded

Contractor:
United Technologies Corporation
Pratt & Whitney

JDMTP Subpanel:
Metals

Advanced Casting Technology for Low Cost Composites

Contract Number: F33615-99-C5300 **ALOG Number: 2557**

Statement of Need

Composite tooling costs have been identified as a high cost area especially in the prototype environment and as production rates continue to drop. Composite cure tools must produce dimensionally accurate parts (matching coefficient of thermal expansion) be affordable, and durable enough for production use. New technologies and methodologies are needed to develop composite processing tools that are low cost, highly durable, have compatible thermal performance characteristics, and short fabrication lead times. The objective of this research is to develop a more affordable method of casting INVAR tooling for composite structures.

Approach

There will be three main areas of investigation. Primary emphasis will be directed to further developing the patternless molding technology that was demonstrated during the Phase I effort to a production setting. This technology may reduce the costs for an average INVAR tool by $100-$200 per square foot and decrease lead times by three weeks. The production of thinner cast face sheets will be investigated. Analysis during Phase I has shown a potential cost savings of $160 per square foot and lead time reduction of one week. The production of tooling with integrally cast stiffeners will also be investigated. Integrally cast stiffeners would aid in processing of the cast face sheet and could potentially reduce costs by $40-$60 per square foot.

Benefits

Benefits include cost reduction and lead time reduction of hard pattern equipment. This technology is expected to impact the cost and lead time of any complex, low-volume casting for which pattern equipment does not exist. Machining cost, lead time, and raw materials would also be reduced for the casting of INVAR face sheets. This technology would transfer to other large plate-like castings.

Status

Active
Start date: March 1999
End date: February 2001

Resources

Project Engineer:
Eric Becker
AFRL/MLMP
(937) 904-4382

SBIR Funded

Contractor:
Waukesha Foundry Incorporated

JDMTP Subpanel:
Composites

Advanced Resin System for RTM/VARTM Processing

Contract Number: F33615-99-C-5308 **ALOG Number: 2559**

Statement of Need

The objective is to develop a composite resin that has adequate processing properties to allow infiltration, by VARTM or RTM, and curing at or below 180° F and which has properties equivalent to aerospace resins now cured at 350° F.

Approach

This Phase I SBIR will focus on developing a resin formulation from commercially available materials and measuring neat resin properties to determine suitability for processing and potential for mechanical performance. Resin properties to be measured include physical properties, dynamic thermal behavior during cure, rheology during cure, kinetics and, after cure, glass transition, and chemical resistance. To determine the suitability of the resin for infiltration and bonding to fiber, fiber wetting characteristics will be tested. Finally, carbon cloth composites will be made in order to evaluate physical, thermal and mechanical properties.

Benefits

Low temperature curing resins for RTM and VARTM make it possible to process composites at lower temperatures and pressures, eliminating the expense and size restrictions of heavy manufacturing equipment such as autoclaves and presses. Processing at these temperatures also alleviates distortion and stress build ups due to temperature excursions, reducing the cost of assembly and post manufacturing rework. Tooling and bagging materials are also less costly.

Status

Active
Start date: May 1999
End date: January 2000

Resources

Project Engineer:
Dr. Frances Abrams
AFRL/MLMP
(937) 904-4380

SBIR Funded

Contractor:
Shade Incorporated

JDMTP Subpanel:
Composites

Advanced Resin System for RTM/VARTM Processing

Contract Number: F33615-99-C-5311 **ALOG Number: 2560**

Statement of Need

The objective of this SBIR Phase I research is to develop new composite resins that will reduce the cost of manufacturing polymer-matrix composite structures by enabling pre-form fabrication, combined with VARTM/ RTM resin infusion and out-of-autoclave curing. Finished articles could then be fabricated quickly with repeatable quality without the investment in autoclaves and their attendant maintenance and support materials. In addition, an advanced low temperature curing resin would allow a whole new range of tooling materials to be used that would increase the affordability of advanced composite structures.

Approach

The program approach is to develop two separate resin systems: one for thermal post cure and one for using E-beam curing. Initially, potential resin systems will be determined and their process limitations documented. From there, the resins will be modified for each method of post cure. At the end of the six month technical effort, VARTM test panels will be manufactured using each method of post cure and then tested.

Benefits

Low temperature curing resins for RTM and VaRTM make it possible to process composites at lower temperatures and pressures, eliminating the expense and size restrictions of heavy manufacturing equipment such as autoclaves and presses. Processing at these temperatures also alleviates distortion and stress build ups due to temperature excursions, reducing the cost of assembly and post manufacturing rework. Tooling and bagging materials are also less costly.

Status

Active
Start date: May 1999
End date: January 2000

Resources

Project Engineer:
Dr. Frances Abrams
AFRL/MLMP
(937) 904-4380

SBIR Funded

Contractor:
Applied Poleramic Incorporated

JDMTP Subpanel:
Composites

Affordable Manufacturing of Advanced Low Observable (LO) Coatings

Contract Number: F33615-98-C-5165 **ALOG Number: 1801**

Statement of Need

This effort is defining, developing and validating an integrated manufacturing process for the fabrication of low cost, high performance LO pigments for formulation into LO coatings.

Approach

The program will define, build, and validate a self contained deposition system, integrate the system into an integrated facility, demonstrate real time intelligent monitoring, and fabricate production samples. This is a multi-phased program. Testing is continuing on the Interim Scale-up Machine (ISM) which was separately funded under another ML contract. Lessons learned from the ISM are being incorporated into the production machine delivered under this contract. Current activity is largely focused upon machine fabrication and pre-planning for the production facility. The next major milestone will be acceptance testing of the integrated web coater that will occur in the second quarter of calendar year 2000.

Benefits

This effort will reduce IR signature of DoD weapons systems at an affordable cost, reduce acquisition cost by up to 80 percent, and provide an assured supply of affordable LO coatings.

Status

Active
Start date: September 1998
End date: October 2000

Resources

Project Engineer:
Michael Urig
AFRL/MLMP
(937) 904-4384

Contractor:
General Atomics Corporation

JDMTP Subpanel:
Composites

Affordable Tool-less Edge Fabrication

Contract Number: F33615-99-C-5314 **ALOG Number: 2612**

Statement of Need

The fabrication of edges for advanced low observable air vehicles involves many materials, manufacturing steps and extensive assembly operations. The resulting manufacturing process is very time consuming, expensive and often produces low quality parts. A lower cost manufacturing method is needed to improve affordability and part quality. Bonding multiple details together within an edge is a challenge. Part fit-up tolerances and bond-line thickness are very difficult to control. Any disbonds that are found after bonding must be reworked prior to moving the edge to the next assembly cell. If an alternative process for edge fabrication that eliminates the bonding and assembly issues could be validated, a significant cost savings could be realized.

Approach

The goal of this program is to produce an F-22 rudder trailing edge using a vacuum assisted resin transfer molding (VRTM) tool-less manufacturing process. The payoff is a significant reduction in cost and cycle time. This process eliminates the skin-to-core bonding step and the fabrication of close-outs, while still producing a part which meets all structural and low observable (LO) requirements. The goal is a 25 percent reduction in manufacturing cost. The edge will be built with F-22 qualified materials to the current F-22 configuration. Only minor changes to reduce complexity and part count will be made to the design, and any changes to pressures and cure cycles will be accounted for through coupon and structural testing.

Benefits

The goal is a 25 percent reduction in manufacturing cost, and equal or better structural and electrical performance. Because this process does not require rate bonding tooling to be fabricated, production tooling cost can also be reduced. NDI and rework cost should also be reduced. It is anticipated that this fabrication technique will be applicable to all F-22 edges and will benefit in the design and fabrication of JSF edges.

Status

Active
Start date: September 1999
End date:

Resources

Project Engineer:
Michael Urig
AFRL/MLMP
(937) 904-4384

Contractor:
Lockheed Martin Corporation

JDMTP Subpanel:
Composites

Affordable Tooling for Composite Structures

Contract Number: F33615-99-C-5302 **ALOG Number: 2558**

Statement of Need

The overall technical objective of this effort is to develop and demonstrate a low cost tooling concept and manufacturing process for fabricating composite structures using the novel localized resistive heating and cast tooling technology developed by Southern Research. Based on the findings and success of Phase I, this Phase II will develop and demonstrate a 'ready for production application' low cost tooling and processing methodology for resin transfer molding (RTM) of composite structures. This Phase II will focus on the Boeing JSF applications and tie this SBIR to the Composite Affordability Initiative (CAI).

Approach

Production Products Manufacturing and Sales proposes to further scale-up the novel tooling and processing methodology developed in Phase I. This will include the selection of tooling materials, formulations, tool surface concepts, and tool fabrication techniques. These areas optimize the tooling materials and fabrication approaches to achieve the maximum potential of this technology for large scale production composite parts.

Benefits

Benefits include cost reduction and lead time reduction for both prototype and production tooling, as well as composite part curing. This technology is expected to impact the cost and lead time of any tooling and RTM-cured composite structure. The concept developed herein will be applicable and beneficial to industries ranging from aerospace to automotive to medical.

Status

Active
Start date: February 1999
End date: February 2001

Resources

Project Engineer:
Eric Becker
AFRL/MLMP
(937) 904-4382

STTR Funded

Contractor:
Production Products
Manufacturing & Sales

JDMTP Subpanel:
Composites

Breathable Release Coatings for Ceramic Tooling

Contract Number: F33615-98-C-5159 **ALOG Number: 1727**

Statement of Need

The development of a high temperature release coating system is of great interest to U.S. Air Force subcontractors Lockheed Martin and Boeing Company. A release coating system that can be used with multiple high temperature (750°+ F) processing cycles would allow the use of re-useable low cost release coated tool to significantly reduce the time and cost of fabricating high temperature composite parts. One of the most promising considerations for cost reduction of advanced composites is optimizing the cost-performance of castable ceramic tooling. There are many benefits of castable ceramic tooling as compared with conventional metal tooling and other tooling materials and methods.

Approach

Utility Development Corporation (UDC) proposes to further improve the performance of high temperature breathable release coatings, for ceramic tooling, capable of performing reliably for multiple cycles at temperatures in excess of 800° F. This will be a continuation of the progress made in Phase I, during which UDC release coatings exhibited good release and controlled breathability for ceramic tooling at temperatures that ranged between 650° F to 700° F.

Benefits

Improved quality and lower part cost are desired features whether the market is military or commercial. The concepts developed herein will be applicable and beneficial to industries ranging from aerospace to automotive to medical. The proposed program will make a significant contribution towards the high temperature processing of advanced composites.

Status

Active
Start date: July 1998
End date: July 2000

Resources

Project Engineer:
Eric Becker
AFRL/MLMP
(937) 904-4382

SBIR Funded

Contractor:
Utility Development Corporation

JDMTP Subpanel:
Composites

Composites Affordability Initiative

Cooperative Agreement Number: Numerous **ALOG Number: Numerous**

Statement of Need

The Composites Affordability Initiative (CAI) is a collaborative partnership structured as an agreement between the Government and industry to jointly attack the issues and areas of cost associated with the use of composites materials in military systems. The Department of Defense, primarily the Air Force and the Navy, will participate along with the four major airframe manufactures — Boeing Seattle, Lockheed Martin, Northrop Grumman, and Boeing St. Louis- in a collaborative effort to jointly develop and mature the essential design and manufacturing processes needed to achieve major cost reductions in composite structures. This will be accomplished by addressing issues which cross the boundaries of cultural, business and technology domains form both the perspective of the Government and industry. The Leadership Integrated Product Team (LIPT) manages the program utilizing the principles of IPPP to accomplish required tasks via focused activity IPTs created to address specific topic areas and issues. Initially, the CAI will focus on fixed wing attack aircraft as they represent the most costly and structurally challenging use of composites. However, the results will be applicable to other aircraft systems, both military and commercial, and could enhance composites use in ground vehicle and ship applications.

Approach

The overarching goal of the Composites Affordability Initiative (CAI) is to significantly reduce the acquisition costs of airframe structures through the revolutionary utilization of composites materials. The specific goal of this effort (Phase II) is to develop the tools and technologies necessary to enable integrated product teams to confidently design, manufacture and integrate with aircraft subsystems an "all-composites" airframe utilizing revolutionary design techniques, innovative manufacturing concepts, materials, processes and advanced business practices, to enable breakthrough reductions in cost, schedule and weight. Initial CAI emphasis will be placed on Joint Strike Fighter (JSF) insertion opportunities.

Benefits

CAI activity will result in a major reduction in the cost of composite structures and expand their application in military systems which can only be accomplished in collaborative effort between the government and industry. The active involvement of all parties, collaborative planning and shared development, early and frequent demonstrations with opportunities for early transition to production is the selected approach to gain wide acceptance of the proposed new revolutionary airframe design and manufacturing processes.

Status

Active
Start date: January 1998
End date: June 2001

Resources

Project Engineer:
Dennis S. Hager
AFRL/MLMP
(937) 904-4597

Contractor:
Northrop-Grumman

JDMTP Subpanel:
Composites

Computer Enhanced Eddy Current Detection of Hidden Substructures, Edges and Holes

Contract Number: F33615-98-C-5154 **ALOG Number: 1729**

Statement of Need

The assembly of aircraft structure involves precision alignment of skins to substructure (bulkheads, frames, spars/ribs, etc.) prior to the drilling and filling of fastener holes. All hole locations and edge distances are constrained to tight tolerances to achieve the lightest structural weight, highest structural integrity, and the lowest radar signature. Closely matched holes that fit snugly to the fasteners at the minimum allowable distance from the panel's and substructure's edge are desired. The current methods for locating holes and edges requires the assembly technician to use hard templates or to view the assembly from the underside to mark the outer skin with edge and hole location markings. Often excess material and edge distances are required to compensate for alignment inaccuracies. Low cost innovative equipment and techniques are needed that provide the assembly technician with accurate and timely information on the edge and hole locations of hidden substructure relative to mating outer skins. This information should include a visual display or markings to assist the aircraft assembly technician in drilling properly aligned holes and verifying edge distance requirements.

Approach

To address this problem of reducing assembly costs while enhancing fastener alignment, the American Research Corporation of Virginia (ARCOVA) has established the feasibility of a hand-held, all-digital eddy current instrument for improved detection and mapping of multilayer aircraft structures. The Phase I project demonstrated the feasibility of using eddy currents to detect subsurface gaps, holes and indentations in a number of sample configurations. The contractor applied digital signal processing technology to develop an advanced eddy current instrument capable of monitoring voltage and current waveforms derived from hidden substructures. The ARCOVA approach is innovative in integrating an eddy current sensor with a mechanical marking system to provide improved precision in locating subsurface features for assembly operations. The eddy current approach is advantageous over non-contact methods of subsurface mapping in the ability to locate features under relatively thick surface layers and in the amenability of this technique to mark the surface position of a subsurface feature without loss of accuracy accompanying position transfer operations.

Benefits

The ability to sense and display hidden structure has a profound impact on both commercial and military markets. The benefits to the Department of Defense and commercial aircraft systems translates into reduced manufacturing costs, higher quality product, reduced cycle times and the opportunity to automate aircraft assembly. Successful completion of the program objectives will result in the development of a miniaturized, hand-held digital eddy current instrument for the detection of hidden substructure edges and holes during aircraft assembly.

Status

Active
Start date: August 1998
End date: August 2000

Resources

Project Engineer:
Michael Urig
AFRL/MLMP
(937) 904-4384

SBIR Funded

Contractor:
American Research Corporation of Virginia

JDMTP Subpanel:
Composites

Design and Manufacture of Low Cost Composites -- Bonded Wing Initiative

Contract Number: F33615-91-C-5729 **ALOG Number: 155**

Statement of Need

Future weapon systems will require even greater use of composite structures to meet the increasing performance and survivability requirements. Composite structures must be reduced in both acquisition and ownership costs to enable future weapon systems to achieve the performance necessary to counter future threats. There is little opportunity to reduce the cost of advanced composite aircraft structures using existing technologies due to limitations in design concepts and methods, material properties, and manufacturing processes. Emerging, innovative new concepts, which will improve advanced composite manufacturing capabilities, will allow for innovative design techniques and will reduce the acquisition cost of composite structures. New structural configurations and design analysis methods need to be developed to use these improved manufacturing processes in an appropriate manner. The purpose of these programs is to achieve a 50 percent reduction in the manufacturing cost of advanced composite structures with an attendant 25 percent reduction in the support cost. These efforts will develop the design/build technology necessary to reduce the cost of wing, fuselage, and engine structures for future aircraft. Each program will demonstrate the use of new emerging design, analysis, and manufacturing technologies implemented through a Concurrent Engineering/Integrated Product Development (CE/IPD) concept. The CE/IPD techniques developed within this initiative will also demonstrate the capability to reduce support costs for future structures that use similar techniques.

Approach

Bell Helicopter Textron has demonstrated new materials and design manufacturing concepts identified as key to achieving a 50 percent reduction in the manufactured cost of the V-22 composite wing. The Bell concept established and implemented a new material form, the pultruded carbon rod, within a new design concept for wing stiffeners. Cost effective use of this rod was enabled through the development of the new manufacturing equipment. In addition to the implementation of the pultruded rod concept, Bell investigated all bonded construction, involving the bonding of thermoset to thermoplastic structures. Using a concurrent engineering format, Bell developed a highly integrated wing structure to reduce assembly cost. Fabrication costs were reduced by selecting the most cost effective match of manufacturing processes to structural requirements. Fabrication methods under this effort included resin transfer molding of stitched preforms and automated tape layup.

Benefits

This project will reduce the manufacturing cost of advanced composite aircraft bonded wing structures by 50 percent.

Status

Complete
Start date: September 1991
End date: August 1999

Resources

Project Engineer:
Vincent Johnson
AFRL/MLMP
(937) 255-7277

Air Force Funded

Contractor:
Textron Corporation

JDMTP Subpanel:
Composites

Design and Manufacture of Low Cost Composites -- Engines Initiative

Contract Number: F33615-91-C-5719 **ALOG Number: 173**

Statement of Need

Future weapons systems will require even greater use of composite structures to meet the increasing performance and survivability requirements. Composite structures must be reduced in both acquisition and ownership costs to enable future weapons systems to achieve the performance necessary to counter future threats. There is little opportunity to reduce the cost of advanced composite aircraft structures using existing technologies due to limitations in design concepts and methods, material properties and manufacturing processes. Emerging, innovative new concepts to improve advanced composite manufacturing capability will allow for innovative design techniques to reduce the acquisition cost of composite structures. This effort provided preliminary data by designing and manufacturing innovative advanced composite engine structures. Future designers will have the ability to verify cost-effective design/build methods. In order to assure that the decisions made have maximum potential to reduce acquisition cost while meeting all pertinent mission requirements, this effort focused on concurrent engineering methods. These methods will help achieve the most cost-effective match of structural requirements to material properties to manufacturing processes.

Approach

The contractor used an integrated design and manufacturing approach to promote significant cost reductions and used the product development team approach to identify technologies that will reduce the manufactured cost of advanced composite engine structures. An overall design concept with a plan for further manufacturing development was established, with the most promising design, material form, fabrication, assembly, and inspection concepts selected. The manufacture of parts and test elements provided cost data to substantiate initial cost estimates. The contractor will design, fabricate, and assemble a full-scale engine duct validation test article. Costs associated with overall fabrication and assembly will be assessed and documented. Projected cost reductions will be compared to actual costs of fabricating the engine duct. An end of contract presentation will be given at the 1999 Defense Manufacturing Conference.

Benefits

- 50 percent direct cost savings.
- 2 percent indirect cost savings.
- Reduce quality cost controls.
- Transition braiding and fiber placement to engine duct components.

Status

Complete
Start date: August 1991
End date: December 1999

Resources

Project Engineer:
Eric Becker
AFRL/MLMP
(937) 904-4382

Air Force Funded

Contractor:
General Electric Company

JDMTP Subpanel:
Composites

Developing a Flexible Mandrel and Semi-Flexible Tooling for Fabrication

Contract Number: F33615-99-C-5301 **ALOG Number: 2383**

Statement of Need

Organic matrix composites structural technology impacts virtually every current and new weapon system. These structures provide critical performance enhancements which enable the DoD to field superior weapons systems. Although organic matrix composites are used in a wide spectrum of vehicle structures, the high cost of these structures may severely limit the implementation of this critical technology to its fullest potential. Therefore, new technologies which allow for the affordable implementation of composite structures must be pursued. Tooling costs have been identified as a high cost area especially in the prototype environment and as production rates continue to drop. Composite cure tools must produce dimensionally accurate parts, (match the coefficient of thermal expansion (CTE) of the part), be affordable to demonstrate the tooling approach in a prototype environment, and be durable enough to meet the requirements of production use. INVAR tools have been shown to meet thermal and durability requirements and are being used extensively on ongoing aircraft production programs. However, INVAR tooling is very expensive and requires significant fabrication lead times. New technologies and methodologies are needed to develop composite processing tools that are low cost, highly durable, have compatible thermal performance characteristics, and short fabrication lead times. The new tooling technology and methodology should address the cost of fabricating both the tool face and substructure. It must provide all the capabilities of internal tooling points, scribe lines, and vacuum ports as available on current INVAR cure tools.

Approach

This contract was awarded as a Phase II Small Business Innovative Research (SBIR) program. In the Phase I, an innovative reconfigurable mandrel compound material for the fabrication of integrated composite structures was developed. The reconfigurable mandrel and the semi-flexible tooling (developed in another research effort) can be reused to process composite structures with different shapes without time-consuming machining. The mandrels can be remolded or reshaped after being used. Demolding can be accomplished easily without any special equipment. In the Phase II, the formulation and processing of the innovative mandrel material will be optimized. An extrusion process will be used to produce this mandrel material in greater quantity. The flexible tooling will be used with both out-of-autoclave and the conventional autoclave composite processing techniques to fabricate integrated tapered hat-shape structures and spars. A series mechanical testing and nondestructive evaluation (NDE), will be performed to assess the quality of these parts.

Status

Active
Start date: January 1999
End date: May 2001

Benefits

The capability of processing integrated composite structures using the reconfigurable tooling technique developed in this research project will have the advantage of reducing part count. This will reduce assembly costs. The tooling cost and lead time will all be dramatically reduced. Other advantages include:

- Mandrel and tooling costs can be orders of magnitude lower
- Mandrel material can be reused for the same of different cavity shapes
- Mandrels can be fabricated in minutes rather than tens of hours
- Mandrel material developed has very high temperature stability, over 500°F
- Short lead time for composite manufacturing
- Rapid prototyping
- Low processing cost
- Mold & parts can be redesigned or modified much quicker

Resources

Project Engineer:
Michael Urig
AFRL/MLMP
(937) 904-4384

SBIR Funded

Contractor:
Wright Materials Research Company

JDMTP Subpanel:
Composites

Dynamic Polymer Composites

Contract Number: F33615-97-C-5126 **ALOG Number: 1536**

Statement of Need

Decreasing defense budgets along with increasing commercial requirements necessitate the development of low cost organic matrix composite structures. A large percentage of the costs are associated with assembly and repair of composite structures. Currently, there are no available joining methods that lend themselves to quick and easy field assembly and repair of aircraft composites. Joining concepts are required that: 1) may be used under field conditions with a minimum of tools/equipment; 2) develop an adequate portion of the strength of the structural members themselves; 3) minimize or eliminate surface preparation; and 4) minimize the need for precise dimensional tolerances. The objective of this project was to build upon the Phase I work to refine the concept and scaleup, and to ready the concept for factory floor or field operations.

Approach

This project addressed applications design, manufacturing and cost impact. A structural connector was be tested to determine capabilities. The prototype was field validated. Dynamic Polymer Composite's (DPC's) patent has been published and the details are now public. No further protection is offered by suppressing the write-up of the formal demonstration of DPC connections. An abstract was submitted to ManTech entitled, "Demonstration of a Dynamic Polymer Composite Connector." This paper was presented at the American Society for Composites 12th Annual Technical Conference in Dearborn, Michigan, in October 1997.

Benefits

The DPC connectors create a smooth stress flow between cylindrical structural members. The DPC connectors have high-module fibers that are pre-stressed during manufacture to be released during assembly when the polymer matrix is heated. Dynamic polymer composite connectors enable a composite airframe to be component assembled.

Status

Complete
Start date: April 1997
End date: September 1999

Resources

Project Engineer:
2nd Lt. Joy Morrison
AFRL/MLMP
(937) 904-4381

SBIR Funded

Contractor:
The Technology Partnership

JDMTP Subpanel:
Composites

Enhanced Pultruded Composite Materials

Contract Number: F33615-96-C-5629 **ALOG Number: 1467**

Statement of Need

Most pultrusion research studies to date, including that of the previous Phase I Air Force Research Laboratory sponsored research (Aerospace Sciences Research and Development, F33615-91-C-5727), have examined simple pultruded shapes (e.g., simple flat or circular geometries), and have related processing conditions of these shapes to the expected mechanical properties of the composite. However, most design applications require products in more complex shapes, and unfortunately for composite materials, knowledge of composite material properties for simple shapes does not imply knowledge of the mechanical properties for the more complex shapes. Complex shaped composites need to be carefully designed for proper fiber placement and alignment, in addition to all those factors that normally affect pultruded composites. The objective of this effort is to manufacture composite materials in an optimized engineering design geometry.

Approach

A major expansion of the previous research will be to manufacture (pultrude) composite materials in optimized engineering design geometries such as I-beams, T-beams, L-beams, or hollow tubes. The use of composite materials in wide ranging design applications will make the study of structural geometries necessary. The manufacture of these shapes will require the use of fiber fabric. In the past research (Phase I) only unidirectional (longitudinal oriented) fibers were employed. The use of fabric will provide an opportunity to vary the mechanical properties as a function of fiber orientation (direction). The research will also use "hybrid" glass/graphite fiber. After manufacturing these shapes for a variety of operational pultrusion parameters (pull speed, fiber volume lay-up and hybridization, and die temperature profile), the composite materials will be tested to determine the mechanical/physical properties.

Benefits

This research will develop a basic understanding of the manufacture of complex pultruded shapes. This understanding will tie the properties of useful structural shapes to those pultrusion process conditions used to produce them. In addition, the structural shapes produced will be studied to provide the most desirable composite material properties by taking advantage of the best combination of properties from both graphite and glass fiber. By using this hybrid composite, using the best of both graphite and glass, the pultrusion process can be optimized to produce useful structural shapes.

Status

Active
Start date: May 1996
End date: December 1999

Resources

Project Engineer:
Dr. Frances Abrams
AFRL/MLMP
(937) 904-4380

Air Force Funded

Contractor:
Rust College/University of Mississippi

JDMTP Subpanel:
Composites

Fiber Placement Benchmark and Technology Roadmap

Cooperative Agreement Number: F33615-95-2-5563 ALOG Number: 1470

Statement of Need

Affordability is the key challenge facing today's aerospace industry. While the weight savings benefits of composite structures have been well documented, part cost remains a major challenge. Fiber placement offers the potential to significantly reduce material waste and labor costs in comparison to conventional part fabrication methods. In addition, fiber placement provides a unique opportunity to optimize structural efficiency and to fabricate large, complex parts not feasible for fabrication by conventional methods. However, the capabilities of fiber placement are not fully understood and the complete benefits of fiber placement cannot be fully realized. The objective of this program was to benchmark the current state-of-the-art in production fiber placement capabilities and to provide a technology roadmap for composites automation technology into the next century.

Approach

The benchmarking effort was documented in a series of fiber placement manuals which provide cost and capability data to optimize designs for the fiber placement process and provide processing data required for repeatable, high quality manufacturing.

Benefits

This effort will reduce material waste and labor costs and optimize structural efficiency. It provides guidelines to the design community and a roadmap for the machine tool builders around fiber placement technology.

Status

Complete
Start date: November 1995
End date: September 1999

Resources

Project Engineer:
Dr. Frances Abrams
AFRL/MLMP
(937) 904-4380

DARPA Funded

Contractor:
McDonnell Douglas

JDMTP Subpanel:
Composites

Field Level Repair/Joining of Composite Structures

Contract Number: F33615-97-C-5125 **ALOG Number: 1537**

Statement of Need

Decreasing defense budgets along with increasing commercial requirements necessitate the development of low cost organic matrix composite structures. Affordability includes all steps of the manufacturing process from starting materials to final inspection. A large percentage of the costs are associated with assembly and repair of composite structures. Currently, there are no available joining methods that lend themselves to quick and easy field assembly and repair of aircraft composites. Joining concepts are required that: 1) may be used under field conditions with a minimum of tools/equipment, 2) develop an adequate portion of the strength of the structural members themselves, 3) minimize or eliminate surface preparation, and 4) minimize the need for precise dimensional tolerances. The objective of this project was to develop an ultrasonic repair/joining technique for field repair of advanced composite structures.

Approach

The approach was to combine ultrasonic lamination and Z-fiber insertion into a qualified repair process for an advanced composite system such as the F-22. A prototype unit has been constructed and process trials are ongoing to determine process parameters and mechanical properties.

Benefits

Composite materials have already found widespread application in the commercial market. Improved quality and lower part cost are desired features whether the market is military or commercial. The concept developed herein is applicable and beneficial to industries ranging from defense and commercial aerospace, to automotive, civil structures, and electrical component industries.

Status

Complete
Start date: May 1997
End date: September 1999

Resources

Project Engineer:
2nd Lt. Joy Morrison
AFRL/MLMP
(937) 904-4381

SBIR Funded

Contractor:
Foster-Miller Incorporated

JDMTP Subpanel:
Composites

Hybrid Composites Manufacturing Braiding/Filament Winding Production

Contract Number: F33615-98-C-5153 **ALOG Number: 1733**

Statement of Need

Under the Air Force ManTech program Design and Manufacture of Low Cost Composites (DMLCC) Engine, a hybrid composite manufacturing technology was developed involving braided and filament wound preform fabrication. The braided/filament wound hybrid composites are proving to be an effective means for fabricating critical, primary load bearing jet engine structures such as a center bypass duct. This is a straight axis part involving both braiding and filament winding with multiple features. Similar work has been done demonstrating the viability of braiding for low cost composite structures in the DMLCC Wing program as well as in wing and fuselage structures in the NASA ACT program. Currently, the braiding and filament winding processes are done on separate machines, necessitating two machines, removal from one machine to the next, shipment to separate facilities, et cetera. By combining or hybridizing the two processes into a single machine, significant process improvements and cost savings can be realized. The objective of this project is to create an automated process for the creation of hybrid unitized structures with integral stiffeners and braiding/filament winding.

Approach

This project will modify the existing braiding machine to incorporate novel extensions to allow slack for integration of stiffeners into the mandrel. A demonstration article (F110 engine shroud) is to be fabricated at the end of the Phase II effort.

Benefits

The fully integrated multi-axis preforming system will have applications in a myriad of industries. In the aerospace industry, it would be ideal for the production of the center bypass duct that has been the focus of the DMLCC Engine program, as well as for the manufacture of non-linear parts such as ducts and fuselage ribs. This technology would also be applicable to a variety of commercial industries such as automotive, medical (prosthetics), sports (hockey sticks, racket sports) and recreation equipment (bicycle components).

Status

Active
Start date: August 1998
End date: July 2000

Resources

Project Engineer:
Eric Becker
AFRL/MLMP
(937) 904-4382

SBIR Funded

Contractor:
A&P Technology Incorporated

JDMTP Subpanel:
Composites

Identification and Quantification of Structural Damage (Structural Repair of Aging Aircraft)

Cooperative Agreement Number: F33615-97-2-5151 **ALOG Number: 1544**

Statement of Need

The objective of this program was to develop, validate and deliver an automated, eddy current inspection system that will give the Air Force an invaluable damage detection tool to help effectively maintain its aging aircraft fleet. The final deliverable is a portable, field-ready inspection tool that will rapidly detect small cracks and corrosion in complex aircraft structures. This tool also has a direct and broad application within the aging commercial aircraft industry. Both economic and safety improvements were realized within both the commercial and military aircraft fleets. A major requirement for activities undertaken as part of this program was to define multiple demonstration/application candidates for any technical effort. A minimum of two Air Force target applications were required for each project. The demonstration System Program Directors (SPDs) defined metrics/gates and fund activities required to implement the results if success is achieved. The second application candidate was required to spur technology transfer.

Approach

The approach included the "as-bid" activities from Northrop Grumman Corporation, which is coupled to the efforts of an Air Force Integrated Product Team (IPT) composed of participants from Air Force Research Laboratory, the Air Logistic Centers (ALCs), Technology Directorates, and SPDs. The team focused on obtaining user participation and buy-in at both the SPD and maintenance levels to assure that if success measures were achieved, the commitment would be obtained in advance to provide implementation resources.

Benefits

This project developed an inspection tool which is potentially applicable to virtually every DoD aircraft. In terms of impact potential per government investment dollar, the project is viewed as outstanding. If the proposed effort is successful, the field of nondestructive inspections (NDI) between programmed depot maintenance inspections will be reduced or eliminated. The probability of inspection (POI) increase equates directly to an increase in aircraft availability — all of which are highly desired benefits and have corresponding reductions in cost. A significant commercial and military market is anticipated for the system due to the time and labor savings that can be realized with by its implementation.

Status

Active
Start date: October 1997
End date: April 2000

Resources

Project Engineer:
Michael Urig
AFRL/MLMP
(937) 904-4384

Air Force Funded

Contractor:
Northrop Grumman Corporation

JDMTP Subpanel:
Composites

Integrated Maintenance and Supply

Contract Number: F33615-96-D-5101 **ALOG Number: 2611**

Statement of Need

This program builds off the Lean Sustainment Initiative which will evaluate the entire sustainment enterprise and identify best practices that apply and can be implemented within the sustainment community. This program will focus on applying lean principles within the OC-ALC Air Accessories commodity area (maintenance and supply) to prove out lean concepts, ensure an efficient operation, reduce cost and flowtime.

Approach

Phase I will map the existing processes and identify constraints and problem areas both process and business practices and policies. Phase II will determine the optimum processes and policies for this area. Phase III will make these changes and run an actual test for 12 months to collect actual data to prove benefits.

Benefits

This program will help identify "best practices" that should be considered for adoption within the sustainment industrial base, enabling it to eliminate waste and achieve a lean enterprise posture. This will assist the Air Force in providing Agile Combat Support to the warfighter.

Status

Active
Start date: October 1999
End date: December 2003

Resources

Project Engineer:
Trixie Brewer
AFRL/MLMP
(937) 904-4370

Air Force Funded

Contractor:
KPMG

JDMTP Subpanel:
Sustainment

Integrated Manufacturing and Quality Control Tools for Affordable Composite Product Realization

Contract Number: F33615-97-C-5146 **ALOG Number: 1593**

Statement of Need

As the aerospace industry moves into the new millennium, the drive towards high performance materials and smart weapon systems is balanced by the economic necessity of building affordable weapon systems. Products manufactured from composite materials are of significant interest to the Air Force due to their unique properties. Presently, there is no comprehensive framework for estimating the life cycle costs for composite products and for evaluating manufacturability of these products. In order to design affordable, high quality products, designers must be able to predict the life cycle costs at an early stage, since over 70 percent of the life cycle costs are determined during the design phase. Life cycle cost or total product cost is composed of processing cost, quality cost, manufacturing system cost, supply chain cost, and environmental costs. Estimation of each of these costs presents a formidable challenge, especially if the product is still at the design stage.

Approach

This program presents a collaborative effort between academia, a defense contractor, and a defense laboratory to develop a methodology for evaluating composite products and implementing a prototype integrated manufacturing and quality control (IMQC) system for specific DoD weapon system programs at a prime defense contractor site.

Benefits

The result of this research will integrate the statistical process control methods for low volume composite production and the composite manufacturability evaluation tools with Air Force weapons programs. The goal of this project is to create an integrated framework for the design and evaluation of advanced composite products based on functional needs, process capabilities, processing requirements, and environmental impact, all which are in the actual weapon system environment.

Status

Active
Start date: September 1997
End date: November 2000

Resources

Project Engineer:
Dr. Frances Abrams
AFRL/MLMP
(937) 904-4380

Air Force Funded

Contractor:
Florida A&M University

JDMTP Subpanel:
Composites

Manufacture of Thermoplastic Composite Preferred Spares

Contract Number: F33615-91-C-5717 **ALOG Number: 172**

Statement of Need

The use of advanced composites in new weapon systems has dramatically increased. Advanced composites help achieve the desired goals of increased range, speed, payload, and supportability. The expanded application of composites into more of the airframe's structures introduces important rate production factors such as tool fabrication lead times and life, part reproducibility and integrity, tooling materials, etc., all of which are important considerations to overall manufacturing costs. In many cases, the component design, tool design, and tool manufacturing are far more costly than producing the parts themselves, especially when lot sizes are relatively small. This program focused on the use of computer-aided manufacturing technologies to develop and validate an integrated design/manufacturing system for non-flight critical structural components. This effort will permit the Air Logistics Centers (ALCs) to efficiently redesign and develop composite secondary structure by providing an automated design and analysis capability. This reduces the risk and span time for replacement of high maintenance items.

Approach

The Integrated Product Manufacturing System (IPMS) is aimed at the designer, analyst, manufacturing engineer and tool designer. Its intended use is the redesign of existing secondary, non-flight-safety critical metal aircraft structure to composites. The IPMS accepts as inputs part geometry, design constraints and production requirements. It automates some drafting and analysis functions, and uses a standard format to share loads, geometry, material properties and other information. These are used to develop part and tool designs, specifications, fabrication instructions and high level cost and schedule information. Validation of the system was accomplished by using it to generate examples of part design and materials/fabrication guidelines for airframe thermoplastic components which have been previously designed and manufactured on other programs. Hardware and software systems were installed at Oklahoma City ALC and Warner Robins ALC, and ALC personnel were trained to use the IPMS and the tool design systems. During Phase III of this effort, the IPMS was used to develop designs for the demonstration articles. The aft nose landing gear door on the C-130 was selected as the demonstration part for Warner Robins ALC. The C-135 nose wheel gear door was selected for the demonstration part for Oklahoma City ALC. A limited remanufacturing capability for the C-130 aft nose landing gear door at Warner Robins ALC was established. A prototype of the final C-130 door redesign concept was fabricated and successfully tested to the requirements provided by WR-ALC. Use of the MATCOPS software resulted in a reduction of 27 percent for the design effort over conventional design. Final cost and weight comparisons were established showing the door to be five pounds lighter than the metal baseline, but resulted in a 12 percent increase in cost. The higher costs were driven by requirements levied upon the design by WR-ALC personnel.

Benefits

This program successfully demonstrated the capability to redesign an existing metal aircraft part to composite at up to 25 percent reduction in design effort. ALC personnel have been trained to utilize this unique new capability to design and analyze secondary aircraft structure.

Status

Complete
Start date: September 1991
End date: December 1998

Resources

Project Engineer:
Ed Hermes
AFRL/MLMP
(937) 904-4598

Air Force Funded

Contractor:
Northrop Grumman

JDMTP Subpanel:
Composites

Manufacturing Technology for Multifunctional Radomes

Contract Number: F33615-93-C-4312 **ALOG Number: 655**

Statement of Need

Multifunctional structures pose many unique and challenging problems related to manufacturing and assembly issues associated with low radar cross section radomes including: the processing of low loss dielectric materials, meeting tight manufacturing tolerance for electrical performance, the fabrication of multilayer sandwich structure, and meeting very stringent requirements for radar cross section performance structural integrity, and lightning strike protection. This program will examine the unique fabrication and assembly problems associated with low radar cross-section radomes. The objectives are to establish and validate reproducible and affordable processes for the manufacture of low observable radomes. The specific goals are to meet current performance specifications while reducing the production costs, assembly variability, and production risks. This technology development is applicable to the retrofit of radomes for existing aircraft as well as advanced fighters with low radar cross-section.

Approach

To reach the objectives, a three-year, three-phase effort was defined. The first phase evaluated alternative manufacturing processes using new low loss, low dielectric materials. During this phase the electrical performance of the selected materials and construction were defined. Additionally, a cost-benefit analysis was conducted and projected savings were compared to the baseline structure. The second phase provided manufacturing verification by using the materials and concepts from Phase I to define tooling and assembly approaches. A full-scale radome was manufactured. Costs were tracked to provide a benchmark for measuring progress in realizing the projected cost and producibility benefits. In the third phase, additional full-scale components were fabricated utilizing the materials, methods, tooling and assembly techniques established in Phase II. Testing was conducted and the results were compared to requirements. As a follow on to the Phase III effort LMSW will develop field repair capability for the radome. LMSW will identify typical damage types and develop repair techniques that will be suitable for use at either the operational or depot level. This task will include an analysis of reparability based on possible damage levels from effects such as impact. Sufficient testing shall be conducted to validate the repair techniques.

Benefits

This effort offers cost-effective solutions to the unique fabrication and assembly challenges associated with low radar cross section radomes. The approach demonstrated under this effort will meet or exceed all current specifications, and provide for a 30 percent reduction in acquisition cost and a 50 percent reduction in assembly span time versus the baseline.

Status

Active
Start date: September 1993
End date: October 2000

Resources

Project Engineer:
Michael Urig
AFRL/MLMP
(937) 904-4384

Contractor:
Lockheed Martin Corporation

JDMTP Subpanel:
Composites

Microwave Curing for Reversible Bonding of Composites

Contract Number: F33615-98-C-5115 **ALOG Number: 2215**

Statement of Need

The objective of this program is to use Reversible Polymeric Adhesive Bonding using variable frequency microwave energy (MW). This would allow military and civilian aircraft manufacturers and operators to assemble, inspect and maintain their aircraft more cost-effectively.

Approach

During Phase I, Aerotech and its partner, The DoE's Oak Ridge National Lab's Center for Manufacturing Technology (ORCMT), bonded and debonded over 200 glass/epoxy substrates, proving the feasibility of this technology. During Phase II the technology will be extended to carbon substrates, and special formulations of thermoplastic adhesives for low and high end-use temperatures will be developed.

Benefits

Variable Frequency Microwave Radiation (VFMW) has been shown to produce more uniform heating of parts which ensures reduced thermal stress, reduced warping and controlled bubble formation. One of the main advantages of using microwave heating for thermoplastics adhesive curing is that the process is reversible.

Status

Active
Start date: April 1998
End date: April 2000

Resources

Project Engineer:
Dr. Frances Abrams
AFRL/MLMP
(937) 904-4380

SBIR Funded

Contractor:
AeroTech Engineering and Research Company

JDMTP Subpanel:
Composites

Structural Repair of Aging Aircraft (SRAA I)

Cooperative Agreement Number: F33615-98-2-5133 ALOG Number: 1629

Statement of Need

The Structural Repair of Aging Aircraft Program Cooperative Agreement is a 28-month effort to increase the Air Force's ability to locate, quantify, repair and monitor structural cracks and corrosion. The primary objectives of the program are to: reduce cycle times associated with detection of cracks and corrosion around installed fasteners; reduce ambiguity in the interpretation of image-based NDE data relative to crack, corrosion and bondline inspections; and improve confidence in bonded repair technology through advances in repair quality assurance and process control. The results of the program will be demonstrated on the KC-135, B-52 & E-3 aircraft while the final application should be Air Force wide.

Approach

This program will focus on four elements of structural repair of aging aircraft: identification and quantification of damage (IDQ); assessment of damage impact (ADI); specific repair materials and processes (RMP); and quality assurance of repairs (QAR). The objective will be accomplished through two separate 24-month efforts (2 PRDAs). The first will focus on IDQ and QAR (both being NDI intense). PRDA 2 will use the results of PRDA 1 to address ADI and RMP as well as extend or refine IDQ and QAR as necessary to reach the final objective.

Benefits

This program will develop, expand and transition the technologies, processes and procedures available to the Air Force to address the bonded structural repair of aging aircraft.

Status

Active
Start date: August 1998
End date: July 2000

Resources

Project Engineer:
Deborah Kennedy
AFRL/MLMP
(937) 904-4392

Air Force Funded

Contractor:
Boeing Corporation

JDMTP Subpanel:
Composites

Advanced Material Processing Initiatives

Contract Number: F33615-94-D-5801 **ALOG Number: 1609**

Statement of Need

Using principles of computer science, material science, and other engineering disciplines as appropriate, scientific methods were developed for designing and controlling selected manufacturing processes such as chemical vapor deposition, isothermal forging, investment casting, and nonconventional machining operations. These methods were based upon systematic, multidisciplinary approaches which consider material behavior, process mechanics, equipment characteristics, and production requirements associated with the manufacture of advanced aerospace components. Also, these methods employed advanced computer technologies such as artificial intelligence based approaches for self-directing and self-improving design and control systems. The scientific methods were validated and demonstrated by using laboratory and pilot-plant processing experiments.

Approach

The specific objectives were: 1) develop self-directing and self-improving systems for real-time control of advanced material processes; 2) develop a memory driven, feature-based design system that integrates product and process design tasks; and 3) demonstrate self-improvement paradigms using a materials processing platform.

Benefits

The goal of this program was to advance the state-of-the-art for manufacturing processes of existing and future aerospace systems such that significant benefits in quality, costs and lead time can be realized.

Status

Complete
Start date: December 1994
End date: July 1999

Resources

Project Engineer:
Dr. Steven LeClair
AFRL/MLMR
(937) 255-8786

Contractor:
Technical Management
Concepts Incorporated

Automated Data Acquisition for In-Situ Material Process Modeling

Contract Number: F33615-97-C-5841 **ALOG Number: 1703**

Statement of Need

Knowledge regarding the interdependency of material, process, and shape for processing functionally gradient materials is progressing at a rate faster than the processing technology and process researchers and/or operators are capable of observing and in amounts of information far exceeding what a human can digest. This requires that the versatility of the processing equipment be used to augment the researcher and/or process operator in adapting to ever-changing processing conditions. Data presentation is crucial to system/operator interaction in directing the process, responding to varying process conditions and subsequently to validate model refinements and new processing knowledge through process discovery.

Approach

The objective of this Phase II SBIR was to first design the data management system around a general purpose micro-kernel to maximize real-time capabilities. Then, combine process modeling and simulation, together with data exploration and discovery to improve the quality and lower the costs of processing advanced thin film materials. The approach was to implement a micro-kernel design for the InfoScribe data acquisition system on a MacIntosh-based computer; implement modeling methodologies to support off-line and on-line data exploration via simulation; and assess the process modeling with application to a number of processes.

Benefits

The principal military application is the acquisition and organization of raw eddy current inspection data for engine structural integrity. The data will enable discovery of material process use patterns associated with detected material fatigue flows and enable simulated inspections to assess future life prediction and flow growth trends. In addition to military applications, the developed technology would have broad commercial appeal in improving the quality and lowering the costs of processing advanced thin film materials ranging from electro-optical materials for semiconductors, superconductors, thin-film displays, etc. All of these commercial applications have analogous opportunities to extend product thermal/fatigue limits with advanced processing, but are constrained by affordability considerations similar to those faced by the DoD.

Status

Complete
Start date: May 1997
End date: May 1999

Resources

Project Engineer:
Dr. John Jones
AFRL/MLMR
(937) 904-4327

SBIR Funded

Contractor:
Infoscribe Technologies Ltd.

Development of a Composite Material Selection Advisor (CoMaSa)

Contract Number: F33615-99-C-5703 **ALOG Number: 2554**

Statement of Need

The relationship among the involved materials, part geometry, cost, production time, process parameters, and final characteristics of composite parts is very complex. This multi-input multi-output relationship cannot be represented automatically with mathematical functions, or rule based artificial intelligence techniques. Optimization of the process parameters and selection of the optimum composites material is very difficult because of the non-linear and discontinuous nature of the problem. The objective of this project is to develop a highly automated Composite Material Selection Advisor (CoMaSA) to select the optimal composite material and process parameters according to design requirements. The resultant product will also evaluate the complexity of the part from the output of CAD programs and estimate the characteristics, cost and production time for the material selected.

Approach

A user friendly CoMaSA will be prepared to help engineers to select the optimal composite material by considering part geometry and desired characteristics. Compared to other available composite material selection program, CoMaSA will save the datebase information in a very compact form by using neural networks and find the optimal solution in very short time by using genetic algorithms. CoMaSA will automatically determine the complexity of the part geometry from the STL output of CAD programs and consider it during the optimization process.

Benefits

This efforts deals with developing a software program that will assist in the design and manufacture of new composite mateials, as well as potentially determining improvements to already existing composite materials. The program has two types of implementation. In the first, an engineer is interested in finding out the properties that a certain composite material has. The engineer can query the CoMaSA, specifying the materials that the composite is made of, and the CoMaSA will output the characteristics of the material as well as output the manufacturing estimates for cost, time and process parameter. This first implementation is a huge benefit to the Air Force, because fundamentally, CoMaSA becomes a very efficient data base for an extremely large set of data, and the access of information with CoMaSA will be extremely fast. The second implementation is even more exciting. Here an engineer can input the characteristics that are desired in the final material, and the CoMaSA will, through genetic algorithm optimization, determine a set of materials and process parameters to develop a composite material to the required performance. This second implementation will bring the Air Force from our current trial-and-error mode of new materials development, into the "Virtual Materials" arena; that is avoiding a lot of wasted time, money and energy with trial-and-error experimentation, and developing the ability to "simulate" the new material on the computer. Once a new material has been simulated with CoMaSA to the performance specifications and the manufacturing specifications, then the material can be physically developed and tested, once instead of multiple trial-and-error times. Our vision here in MLMR is to provide the Air Force with "Virtual Materials Research " for all materials and all materials processing, not just composites. CoMaSA will be a first step, potentially providing an algorithm for this "Virtual Materials" work that can be expanded and applied to the many other materials of interest to the Air Force.

Status

Active
Start date: March 1999
End date: August 2000

Resources

Project Engineer:
Dr. Claudia Kropas-Hughes
AFRL/MLLP
(937) 255-9795

Contractor:
Florida International University

Intelligent Processing of Materials for Chemical Vapor Infiltration

Contract Number: F33615-96-C-5839 **ALOG Number: 1618**

Statement of Need

When applied to chemical vapor infiltration (CVI) processing, the proposed process controls would have major impact on reducing products costs by increasing product quality and reproducibility. Additional cost reduction would follow from the competition engendered by the wide spread dissemination through the private sector of CVI technology that would result from a more reliable and controllable process. Furthermore, due to the process model independence of the IPM system, the potential for spin off applications to a wide variety of other processing requirements, such as for CVD, PLD, PVD, MBE and composite cure, is very considerable. Thus, IPM could be an enabling technology for a variety of materials processes which currently are too costly to be economically viable across a wide commercial spectrum.

Approach

During the Phase I effort, an integrated, three-level intelligent processing of materials (IPM) control approach was developed. The components of that approach were: a hierarchical control structure, a process model and an in situ sensor. During the Phase II effort, software for the three-level hierarchical control structure was developed including the process model to train a rapid convergence artificial neural network (ANN) for dynamically identifying the process trajectory and redirecting the process in real-time, the in situ sensor to provide materials processing data in real-time, and a process supervisor and health monitor completes the control system. This integrated control system is used for CVI processing of SiC CMCs to further train the ANN and refine the processing model.

Benefits

The objective of this Phase II SBIR was the implementation of an integrated, three level IPM controls system for microwave and FR heated chemical vapor infiltration (CVI) system, and the corresponding development of appropriate in-situ sensors necessary to affect control.

Status

Complete
Start date: December 1996
End date: December 1998

Resources

Project Engineer:
Dr. Claudia Kropas-Hughes
AFRL/MLLP
(937) 255-9795

SBIR Funded

Contractor:
Technology Assessment and Transfer Incorporated

Integrated Substrate and Thin-Film Methods

Contract Number: F33615-98-C-5138 **ALOG Number: 1976**

Statement of Need

The purpose of this research was to develop a suitable compressed representation for materials data and then construct, train, and exercise a "Creativity Machine" which computationally explores and analytically optimizes thin-film materials. Under the patented "Creativity Machine" paradigm, exposure of an artificial neural network cascade to various forms of synaptic noise tends to drive it into activation states representing new and plausible chemical species. Allowed to run in this 'dreaming' mode, immense databases may be populated with materials that have a high likelihood of being synthesized. While many of these hypothetical materials are anticipated to be thermodynamically stable, they are most likely kinetically inaccessible via typical bulk chemistry. However, since modern thin film technology allows a wide range of exotic compositions and stoichiometries via deposition, surface treatments, and nano-fabrication, it is anticipated that this newly acquired theoretical database will form a comprehensive roadmap to the formation of previously unattainable materials that offer significant technological advantages.

Approach

A recently patented connectionist paradigm, called the "Creativity Machine," is naturally suited to generating and evaluating concepts that are distinct from all previous training exposure. In the case of thin film growth and removal, the creativity machine may readily experiment with and evaluate alternative processing routes, finally recommending all growth and/or etching paths that lead to desired stoichiometric and crystallographic film properties. Furthermore, it may design any thin film process within the constraints imposed by environmental compliance regulations.

Benefits

This exploratory development program developed a compression technique for materials data, suitable for use as input to neural network training, and a "Creativity Machine" to computationally explore and analytically optimize thin-film materials growth via molecular beam epitaxy (MBE). From this database, application specific material property requirements become the search parameters which allow for the generation of an ordered list of existing or novel candidate materials tailored to specific needs.

Status

Complete
Start date: April 1998
End date: October 1998

Resources

Project Engineer:
Capt. David Conrad
AFRL/MLMP
(937) 255-8787

SBIR Funded

Contractor:
Imagination Engines
Incorporated

Interactive Simulation System for Design of Multi-Stage Manufacturing Technology

Contract Number: F33615-98-C-5114 **ALOG Number: 1932**

Statement of Need

Materials insertion applications and spare components for aging aircraft systems offer tremendous opportunity to introduce innovative methods, processes and material systems to reduce weight and costs while improving wear, temperature and strength performance. The need is for material process design methods which consider alternative processing which lead to significant reduction in design and fabrication times. Of particular interest is the design and fabrication of precision tooling to enable materials substitution or replacement components that are lighter, stronger and less expensive than might be otherwise attained through conventional forging, casting and machining operations. Demonstration of reduced part turnaround and delivery with cost savings of 50 percent are a targeted goal. Methods, processes and materials should be functionally integrated via a feature-based design environment allowing selection and optimization of manufacturing methods, processes, and materials for structural aircraft and engine components. The objective of this exploratory development program is to develop a extensible computer platform for the integrated simulation-and-optimization-based design of multiple stage manufacturing processes, to explore the market for this platform, to define the system architecture, to identify model sources, and to demonstrate the feasibility of the approach.

Approach

For metal forming processes, a technical strategy was established for embedding analytical models of basic transport phenomena into a feature-based design system which includes geometric, microstructure, and processing features. The system architecture combines user-defined workpiece objects with user-defined sequences of process and equipment objects. Within the system, process objects are coupled with graphical modules to display relevant information (such as speed, load, geometry, etc.) and simplify user interaction with the simulation.

Benefits

Dual use of this exploratory research is foreseen for integrated shape, material, and process design of high performance metals, ceramics and polymers. Aircraft and automobile propulsion system vendors will provide tooling for forming new higher temperature alloys. The integration of virtual metal forming stages will provide users with important information about interdependencies among manufacturing stages, and allow for more cost-effective optimizations of complex manufacturing operations.

Status

Active
Start date: April 1998
End date: March 2000

Resources

Project Engineer:
David Conrad
AFRL/MLMR
(937) 255-8786

SBIR Funded

Contractor:
Austral Engineering

Materials Processing Technology Initiatives

Contract Number: F33615-96-D-5835 **ALOG Number: 1619**

Statement of Need

This program will advance in-house materials processing (design and control) research which encompasses non-structural tribological coatings and inorganic (though biologically based) electro-optical materials; and structural metal alloys, intermetallics, polymer, metal and ceramic composites in the direction of virtual materials research by the 21st century. Research in areas such as high and low cycle fatigue, non-destructive inspection, super alloys and intermetallics research will benefit from electronic access to Air Logistic Centers's engine inspection results on a continuing basis and evolving both material and processing research in near real-time towards the immediate needs of aging systems. The goal of this program was to advance computational methods toward virtual materials and processing research such that significant improvements in research quality (improved atomic-scale control of thin-film technology), costs (more affordable alternative materials and processes) and response time (to accelerate the current 15 year cycle from concept to validation of new weapon system materials) while enhancing technology investments that have been made in the state-of-the-art for materials processing of existing and future aerospace systems. Also, to enable (by means of a materials and processing information highway) transition and transfer of materials processing technology more effectively and to a more pervasive set of applications.

Approach

Research addressed advanced computing and engineering methods for automated materials process analysis, synthesis and discovery, integrated materials-shape-process design and self-directed materials process control. In-house research was transitioned through innovative and novel "need/problem-specific" enhancements and extensions to existing technology. Such enhancements and/or extensions involved interdisciplinary and cross-functional collaboration with Air Force and other customers as well as other federal and state agencies, and defense industrial sectors. The research strategy was to collaborate with other government and industrial organizations with specific technology needs that have the potential to benefit from on-going research results and to facilitate the enhancement and extension of those results.

Benefits

The goal of this program was to advance the state-of-the-art for manufacturing processes of existing and future aerospace systems such that significant benefits in quality, costs and lead time can be realized.

Status

Active
Start date: September 1996
End date: April 2001

Resources

Project Engineer:
Dr. Steven LeClair
AFRL/MLMR
(937) 255-8786

Contractor:
Technical Management
Concepts Incorporated

Simulation-Based Design System for Multi-Stage Manufacturing Processes

Contract Number: F33615-98-C-5161 **ALOG Number: 1720**

Statement of Need

The objective of this project was to develop a software tool capable of designing manufacturing processes for components produced from bulk materials. The software tool is able to incorporate user-defined mathematical models of the process physics and cost factors. The software tool employs mathematical optimization methods to calculate the best values of the adjustable design parameters.

Approach

Analytical models of basic transport phenomena were embedded into simplified process models to facilitate a feature-based analysis and automated designed software system. The system employs state-of-the-art geometric and feature-based modeling techniques to facilitate model development. It uses modern numerical optimization algorithms to perform automated, but user-guided, design parameter calculations. In order to maximize overall accomplishments, work will be in coordination with related AFRL/MLMR efforts.

Benefits

Simplied models will allow product and process engineers to rapidly assess multiple manufacturing processes and variations to quickly and efficiently determine the most cost effective process routing needed to manufacture a finished part from billet or other bulk material form. Embedded optimization algorithms will automatically initiate multiple variations for a particular process model, thereby assessing a broad spectrum of process variables in a matter of minutes. This will allow rapid determination of the lowest-cost processing route to manufacture a product while meeting performance, quality or other product requirements. It will facilitate and encourage true IPPD while product development is still in the concept stage, before obtrusive processing cost factors are embedded in the product design.

Status

Complete
Start date: August 1998
End date: August 1999

Resources

Project Engineer:
Dr. W. Garth Frazier
AFRL/MLMR
(937) 255-8786

Contractor:
Technirep Incorporated

Simulation Based Design System for Multi-Stage Manufacturing Processes

Contract Number: F33615-98-C-5162 **ALOG Number: 1721**

Statement of Need

The objective of this STTR Phase I project was the conceptual development and demonstration of simplified models for the various processes such as forging, heat treatment and machining used in multi-stage manufacturing of components made from difficult-to-form materials. These models are vital for the success of an AML-based optimization and simulation platform concurrently under development by AFRL/MLMR.

Approach

A judicious combination of empirical, geometrical, analytical and numerical methods was used to develop fast acting process models for forging, homogenization, stress relief at elevated temperature, heat-up and cool-down, and machining distortion. Simplified cost models were also developed. The models for cool-down and machining distortion covered a wide range of component complexity. The primary focus of the effort was on the development of models that accounted for the essential physics of the various processes, were easy to use, required little CPU time to run, and can be easily integrated into the AML-based optimization and visualization platform.

Benefits

Models developed under this project, when integrated into the AML-based optimization and optimization platform will allow for rapid evaluation of alternate materials, processing sequence and process parameters for affordable manufacturing of complex components made of difficult-to-form materials used in military and commercial aircraft systems. Using integrated multimedia technologies, it will be possible to make the design system accessible remotely so that designers, manufacturers, and customers can use it in a collaborative fashion during all stages of the product realization process.

Status

Complete
Start date: August 1998
End date: August 1999

Resources

Project Engineer:
Dr. W. Garth Frazier
AFRL/MLMR
(937) 255-8786

SBIR Funded

Contractor:
Modern Computational Technologies Incorporated

Simulation-Based Design System for Multi-Stage Manufacturing Processes

Contract Number: F33615-98-C-5163 **ALOG Number: 1722**

Statement of Need

The objective of this project was to develop a software tool capable of designing manufacturing processes for components produced from bulk materials. The software tool is able to incorporate user-defined mathematical models of the process physics and cost factors. The software tool employs mathematical optimization methods to calculate the best values of the adjustable design parameters.

Approach

A simulation-based software design tool was developed that includes a feature-based representation of the part to be manufactured. Material data is extracted from a comprehensive database of materials. Unit processes are simulated using simplified models that address part features. Optimization methods were applied to determine the process type and sequence of operations that provides a best trade-off between performance and cost.

Benefits

By using simplified efficient numerical models that are based on sound physical principles, a significant decrease in manufacturing process design time can be realized. A corresponding decrease in time for process implementation can also be realized. The net benefit is a time and cost savings for parts produced by thermo-mechanical processes such as forging and heat treatment.

Status

Complete
Start date: August 1998
End date: April 1999

Resources

Project Engineer:
Dr. W. Garth Frazier
AFRL/MLMR
(937) 255-8786

SBIR Funded

Contractor:
Deformation Control Technology Incorporated

Thin Film Growth Simulation Using Cellular Methods

Contract Number: F33615-98-C-5138 **ALOG Number: 1975**

Statement of Need

The purpose of this research was to demonstrate the simulation of multi-species thin-film growth that is fast, displays on a desktop computer, and uses a unique combination of cellular automata, state space, and neural nets methods. Cellular automata, once extended and applied to atomic level simulation, offer a promising approach to modeling large atomic arrays. Inside of that structure, integrated neural nets will significantly reduce the time needed for computing atomic positions and allow a more real-time capability than traditional methods. Further developments in Phase II seeks to more rigorously validate this improved modeling approach against molecular dynamics or Monte Carlo methods, and to address issue of scale change from atomic up through micron or even millimeter scales.

Approach

As part of this effort, simulation software was developed that implements a physical model of film growth. A novel combination of cellular automata, state space, and neural networks were applied to reduce computational burdens to allow near real-time performance. Visual displays, simulation archiving, and simple user-interfacing was developed to enhance both the design of engineered materials and the development and tailoring of the processing sequences to achieve pre-defined film properties and characteristics. The model used, based on probability and energy barriers, appears to be physically consistent with theoretical expectations and actually processed materials.

Benefits

This exploratory development program developed a computationally tractable and user-friendly simulation system for simulating, comprehending and comparing thin-film growth. Results of simple thin-film simulations indicate that this approach can successfully operate on a desktop computer (Macintosh Power PC), and this specific software can be used to simulate film growth for molecular beam epitaxy (MBE) and pulsed laser deposition (PLD) processes.

Status

Complete
Start date: April 1998
End date: October 1998
Final Report No.
AFRL-ML-WP-TR-1999-4028

Resources

Project Engineer:
David Conrad
AFRL/MLMR
(937) 255-8786

SBIR Funded

Contractor:
AVXM Partnership

Thin Film Growth Simulation Using Cellular Automata, State

Contract Number: F33615-99-C-5700 **ALOG Number: 2552**

Statement of Need

The objective of this exploratory development program is to develop a computationally tractable and user-friendly simulation system for simulating, comprehending, and comparing process-specific thin-film growth.

Approach

AvXm is developing models of thin film growth that utilize a combination of cellular automata and neural net approaches. The bases for the models are molecular dynamics and adsorption/surface physics and chemistry. The majority of the technical effort is directed towards gas cluster ion beam (GCIB) processes, including PLD and MBE as basic starting points. Scaling from atomic to micro scales is planned by developing methods for this transition. Access to databases on various processes is to be addressed by use of interfaces via internet browsers to data. Thin film removal processes are included since the GCIB process can be used for such removal.

Benefits

Benefits of this project include: significant broadening of materials design capability; reduction in cost of research via time savings; expanded capability to model real materials; improved visualization capability for process design; and enhanced process refinement via modeling and simulation.

Status

Active
Start date: April 1999
End date: April 2001

Resources

Project Engineer:
Dr. John Jones
AFRL/MLMR
(937) 904-4327

SBIR Funded

Contractor:
AVXM Partnership

WEBADE: The Web-Enabled Agent-Based Design Environment

Contract Number: F33615-99-C-5903 **ALOG Number: 2556**

Statement of Need

The objective of this effort is to develop a design environment that captures the relationships between entities in a design process and uses behavior pattern recognition and formation to create a knowledge base of standard practices to provide assistance to designers.

Approach

Wizdom plans on dividing this work into five major tasks. The first task involves gathering information through literature searches and analysis of current commercial systems that use similar approaches. After information is gathered, the task of developing a formal architecture for the agent-based system will be performed. Two projects that involve design activities will be selected and reviewed for the utilization of the intelligent agent architecture as the third task. The fourth task will involve modeling the projects reviewed in task three to use the intelligent architecture. This work will lead to the fifth and final task of developing a proof-of-concept prototype of the intelligent agent system.

Benefits

This effort will develop and incorporate a powerful "intelligent" engineering design assistant tool to enhance the process of engineering and design solutions applicable to aircraft system and subsystem designs. Wizdom Systems Incorporated's previous DoD projects, include Readiness Assessment and Planning Tool Research (RAPTR), Human Issues in Information Technology Implementation (FRAME/WORK), and Feature-based integrated design tool for mechanical design (WIZARD). These projects developed strong commercially viable products for the government which will have enhanced capabilities through the incorporation of the developed intelligent agent technology.

Status

Active
Start date: April 1999
End date: January 2000

Resources

Project Engineer:
Alan R. Winn
AFRL/MLMR
(937) 904-4332

SBIR Funded

Contractor:
Wizdom Systems Incorporated

Web-Based Collaborative Environment with Knowledge Driven Agents

Contract Number: F33615-99-C-5705 **ALOG Number: 2555**

Statement of Need

The overall objective is development of the Web-based collaborative environment with knowledge-driven agents for monitoring, gathering, and organizing activities and interactions that are a part of the design process for reuse as knowledge within the context of an application or domain.

Approach

Technosoft plans to divide the total work into two basic efforts. First, they will develop a web-based collaborative environment with knowledge-driven agents that can be used by the government and commercial companies in multidisciplinary, distributed, interactive design activities throughout the World Wide Web. In order to accomplish this effort, research of the implementation of agents as objects in an Adaptive Modeling Language environment is required, as well as research in methods of pattern identification, storage, retrieval, and correlation, and in extending the AML environment to support Java applets. After this effort, Technosoft plans on demonstrating the use of this environment by monitoring and populating the knowledge-base of existing AML-based applications, including Lockheed Martin Electronics & Missiles Interactive Missile Design and Interactive Gimbal Design, for reuse.

Benefits

Successful development of this technology will provide a system that will reduce cycle time and impact engineering and production cost, enabling quick response to the fast-paced development of new products and processes. Various DoD programs can benefit from this capability, gaining assistance in the product concept and validation stages; assessing and analyzing the design-to-production automation of aircraft and missile systems. These capabilities can extend to commercial industry and there provide a dual-use technology.

Status

Active
Start date: May 1999
End date: January 2000

Resources

Project Engineer:
Alan R. Winn
AFRL/MLMR
(937) 904-4332

SBIR Funded

Contractor:
TechnoSoft Incorporated

X-Ray Sensors for Real-Time Control of Thin Film Deposition

Contract Number: F33615-98-C-5135 **ALOG Number: 1974**

Statement of Need

Intelligent materials processing requires sensors that can assess materials properties in situ and in real time at the microscopic level. Data from these sensors would be used to control processing in near real time, to accelerate development of new materials systems, and to enable the development of a virtual materials processing environment, a goal that will greatly reduce both the cost and time needed to develop new materials systems. Few sensors currently exist that can provide the kind of information needed. The goal of the effort was to demonstrate the feasibility of performing in situ, real time x-ray measurements on thin films during magnetron sputtering. The x-ray measurements considered were reflectivity, diffraction, and fluorescence. From these measurements, the thin film residual stress, texture, microstructure, surface morphology, microchemistry, and crystal phase relationships can be determined, and then used to control these properties during sputtering. As a result of this effort, a concept design was completed that, when implemented, would be adaptable to a wide range of sputter deposition systems.

Approach

During Phase I effort, the feasibility of x-ray sensors for in situ, real-time process control of magnetron sputter deposition of thin films was demonstrated. This was achieved by delineating relationships between microscopic film properties and deposition conditions. In addition, one design was prepared to adapt appropriate sensors for measuring x-ray reflectivity and fluorescence to in situ measurements, and a second design for a heated sample stage and goniometer was developed.

Benefits

X-ray sensors offer a vast improvement over current in situ sensor techniques. Recent advances in high energy high resolution x-ray generators coupled with modern advanced photon detecting systems have made real-time data acquisition during Physical Vapor Deposition (PVD) a laboratory reality.

Status

Complete
Start date: April 1998
End date: October 1998
Final Report No.
AFRL-ML-WP-TR-1999-4013

Resources

Project Engineer:
Dr. Claudia Kropas-Hughes
AFRL/MLLP
(937) 255-9795

SBIR Funded

Contractor:
Technology Assessment and Transfer Incorporated

X-Ray Sensors for Real-Time Control of Thin Film Deposition

Contract Number: F33615-99-C-5702 **ALOG Number: 2553**

Statement of Need

Intelligent materials processing requires sensors that can assess materials properties in situ and in real time at the microscopic level. Data from these sensors would be used to control processing in near real time, to accelerate development of new materials systems, and to enable the development of a virtual materials processing environment, a goal that will greatly reduce both the cost and time needed to develop new materials systems. Few sensors currently exist that can provide the kind of information needed. X-ray sensors offer a vast improvement over current in situ sensor techniques. Recent advances in high energy high resolution x-ray sources coupled with modern advanced photon detecting systems have made real-time data acquisition a laboratory reality. The objective of this program is to develop a user-friendly x-ray system for pulsed laser deposition (PLD) thin-film growth.

Approach

During Phase I effort, the feasibility of x-ray sensors for in situ, real-time process control of magnetron sputter deposition of thin films was demonstrated. This was achieved by delineating relationships between microscopic film properties and deposition conditions. In addition, one design was prepared to adapt appropriate sensors for measuring x-ray reflectivity and fluorescence to in situ measurements, and a second design for a heated sample stage and goniometer will be developed. For the Phase II effort, the designs will be implemented, tested and installed at AFRL/ML.

Benefits

The seamless integration of an x-ray sensor into a PLD process for PC-based data acquisition, material characterization with known databases, and process control will lead to improved process understanding, higher quality films, time savings, and reduction in cost.

Status

Active
Start date: March 1999
End date: October 2000

Resources

Project Engineer:
Dr. John Jones
AFRL/MLLP
(937) 904-4327

SBIR Funded

Contractor:
Technology Assessment and Transfer Incorporated

Laser Protective Eyewear (LPE)

Contract Number: **ALOG Number:**

Statement of Need

The objective of this project is to establish a highly responsive, affordable production capacity for thin film dielectric coatings on polycarbonate to make laser protective eyewear meeting defense needs. This project will assure that domestic producers are available to supply these devices in sufficent quantities to protect military personnel from laser threats and at affordable prices. Warfighters are highly susceptible to mission-compromising impairment and permanent eye damage from rapidly proliferating sources of laser threats and friendly force hazards. Commands in each of the services have high priority efforts in the development, demonstration, and procurement of LPE. Potential commercial uses include protection for medical and industrial personnel who work with lasers, as well as protection for police and commercial pilots as laser illuminators proliferate.

Approach

Title III financial incentives will be used to establish a flexible manufacturing capability of at least 30,000 units per year to meet service requirements for LPE. The project will require cost sharing, business and marketing plans, cost and process variability reduction, along with evaluation and qualification to service requirements. Purchases and purchase commitments will provide incentives for capital equipment and qualification. A 36-month project is anticipated. To ensure that the requrements of each service are met, scientists, engineers, and program managers will provide technical assistance to the Title III Program Office from the AFRL Materials and Manufacturing Directorate, Air Force Life Support System Program Office, U.S.Army Soldier Systems Command, and the Naval Air Warfare Center.

Benefits

LPE is essential to today's warfighters. This project will reduce the technical risk of manufacturing and improve the quality of LPE, lower per unit cost, increase responsiveness and flexibility to manufacture LPE at reduced lead times, and assures a responsive supply to meet changing threats and hazards.

Status

Pre-award

Resources

Project Engineer:
Philip Tydings
AFRL/MLMP
(937) 255-9665 ext. 223

Title III Funded

Contractor:

Power Semiconductor Switching Devices (PSSDs)

Contract Number: F33615-98-C-5853 **ALOG Number: 1878**

Statement of Need

The objective of this project is to establish an assured, affordable, and commercially viable production capability for high quality power semiconductor switching devices (PSSDs). These solid-state devices replace electromechanical switches for both medium and high-power military and commercial electrical applications. PSSDs have increased switching efficiency and power handling capability while having reduced space requirements, acquisition costs, and life-cycle costs compared to electromagnetic switches. They are pervasive in a wide variety of power generation, control, conversion, and conditioning applications in both defense and commercial sectors.

Approach

Title III financial incentives will be used to transition a variety of devices to full-scale manufacturing, improve yield, quality and affordability, as well as target military and commercial insertion opportunities. To ensure that the requirements of each service are met, technical assistance to the Title III Program Office will be provided by scientist and engineers from AFRL Materials and Manufacturing Directorate, AFRL Propulsion Directorate, the Office of Naval Research, and the Army Research Laboratory.

Benefits

PSSDs are essential to the development and deployment of advanced Air Force, Navy, and Army "more-electric" weapon systems, removing a major barrier to replacing hydraulic systems with electrical systems as well as providing power switching solutions for directed energy weapons and electromagnetic launchers.

Status

Active
Start date: August 1998
End date: December 2003

Resources

Project Engineer:
Philip Tydings
AFRL/MLMP
(937) 255-9665 ext. 223

Title III Funded

Contractor:
Silicon Power Corporation (SPCO)

Semi-Insulating (SI) Indium Phosphide (InP) Wafers

Contract Numbers: F33733-97-C-1022/1023 **ALOG Numbers: 1502/1549**

Statement of Need

The objective of this project is to establish viable, long-term, world-class manufacturing capabilities for Indium Phosphide (InP). InP is a compound semiconductor material that is critical to a variety of optoelectronic and very high-frequency, millimeter wave, and high-power microwave electronics. DoD is investing heavily in the development of InP-based devices; however, the manufacturing infrastructure for InP wafers production is not capable of meeting DoD requirements with respect to quality, price, size and availability. Increased domestic production capacity for InP is required to support current and future needs for both military and commercial applications. Systems requiring InP include the following: BAT, BCIS, MILSTAR, GPS, MILSATCOM, GBR, F-22 and F-15. The unique properties of InP cause it to be an enabling technology. Unlike silicon, InP is intrinsically resistant to radiation. Important uses of InP are in the fabrication of heterojunction bipolar transistors (HBTs) and high-electron mobility transistors (HEMTs) for analog, digital and optoelectronic devices. Title III incentives will be used to enable transition to full-scale manufacturing, improve affordability and quality, target military systems insertions, and leverage government investments.

Approach

Each of the two contracts is a single-phased effort aimed at establishing an economically viable production capability for semi-insulating indium phosphide wafers. The effort consists of eight tasks which include aggressive marketing and business development, optimizations of crystal and wafer (75/100mm) growth processes, cost reduction, production scaleup, material qualification and wafer distribution.

Benefits

Specific benefits and gains expected to be achieved by the project are: improved 75/100mm wafer quality (uniformity, consistency, surface preparation, defect reduction); increased 75/100mm boule/wafer yield; cost reductions of 50 percent; the establishment of partnerships for material evaluation/qualification; and demonstration of production capability for this enabling technology. The project also seeks to provide wafers to government, industry, and universities for materials characterization which is expected to lead to a greater understanding and insertion of this material in electronic systems. The overall benefit expected from the project is a clear path for each contractor to follow in achieving business viability in the production of InP wafers for commercial and military use.

Status

Active
Start date: May 1997
End date: January 2000

Resources

Project Engineer:
John Blevins
AFRL/MLMP
(937) 255-3701, ext. 226

Title III Funded

Contractors:
American XTAL Technology (AXT)

M/A-COM, Inc.

Silicon Carbide (SiC) Substrates

Title III

Contract Number: F33615-99-C-5316/17/18 **ALOG Number:**

Statement of Need

High power density electronics and electronic power management are essential ingredients in future defense technologies which, in many cases, already exceed the basic physical properties of silicon (SI) based semiconductor devices. Future requirements for high temperature, high power applications will also exceed the capabilities of second generation semiconductor materials such as gallium arsenide (GaAs) and indium phosphide (InP). Semiconductor devices fabricated on silicon carbide (SiC) will enhance the performance capabilities of current devices in critical military applications. The physical properties of SiC translate into semiconductor devices, sensors, and subsystems that can operate with ten times higher breakdown voltages, ten to one hundred times higher current densities, in severe hostile physical environments, at higher switching frequencies and at extremely high power levels.

Approach

The focus of the Title III SiC program will be on fostering an expansion in the number of substrate suppliers, reducing production costs, enhancing substrate quality and ensuring long-term viability. This approach will position the domestic SiC substrate suppliers to respond to the higher volumes and significantly lower unit costs that will be required to initiate commercial acceptance and sustain the market pull for this strategic material.

Benefits

Specific benefits and gains expected to be achieved by the project include: establishment of a reproducible 75mm production process; 50 percent improvement in production yields; 50 percent reduction in production cost; enhancement in substrate quality; and demonstration of 100mm production process.

Status

Active
Start date: August 1999
End date: December 2002

Resources

Project Engineer:
John Blevins
AFRL/MLMP
(937) 255-9665

Title III Funded

Contractor:
Cree Research Incorporated
Airtron Division of Litton Systems
Sterling Semiconductor

Silicon on Insulator (SOI) Wafer

Contract Number: **ALOG Number:**

Statement of Need

The objective of this project is to establish a long-term viable, fully integrated, flexible, domestic, merchant manufacturing capability for large diameter (4-8 inches), thick and thin SOI wafers. Semiconductor devices fabricated on affordable SOI wafers are critical to a variety of military and commercial systems. Semiconductor devices of direct interest to the military have high performance, low power, and radiation hardened (RAD HARD) attributes, in aggregate or combination, i.e., power integrated circuits, analog bipolar circuits for wide dynamic range analog-to-digital converters (ADC) and digital-to-analog converters (DAC), smart power, memory, and processing. These devices are needed to maintain current military systems, procure upgrades, or build new systems, ranging from portable communication equipment, radar, electronic countermeasures, defense and counterstrike missiles to satellites. Commercial applications mirror military requirements, due to the similar need for high speed and wide dynamic range analog, ADC and DAC, smart power, and lower cost devices to support the expanding commercial satellite communications market.

Approach

In order to achieve this challenging objective, specific Title III financial incentives will be used to establish and demonstrate a 1.4 million square inch per yer production capacity for SOI wafers to meet increasing military and commercial demands. The project includes cost sharing, business and marketing plans, teaming with military and commercial customers for wafer evaluation and qualification, and active marketing and selling SOI wafers to satisfy military and commercial customers' current and future requirements. It will improve wafer quality, obtain certification to ISO 9000 quality standards, increase yields, and reduce production costs.

Benefits

SOI technologies represent a low technical risk, cost effective approach to meet the growing demand for increased performance for current devices, built on the universal standard bulk silicon. As these devices translate from bulk silicon designs and are optimized for SOI designs, critical system performance criteria like radiation resistance lower power or increased speed will be easily met as they are installed in current or future military systems or satellites.

Status

Active
Start date: November 1999
End date: October 2003

Resources

Project Engineer:
Eric Pohlenz
AFRL/MLMP
(937) 255-9665, ext. 224

Title III Funded

Contractors:
Intersil

Title III

Titanium Matrix Composite Turbine Engine Component Consortium (TMCTECC)

Cooperative Agreement Number: F33615-94-2-4439 ALOG Number: 1286

Statement of Need

Modern aircraft performance is directly related to "thrust to weight" ratio of engines and the combined weight of the aircraft structure, systems, subsystems, and fuel. Titanium Matrix Composites can provide engine manufacturers and aircraft companies the capability of significantly reducing weight while providing increased performance. Unfortunately these materials are very expensive and the production base does not exist to affordably and routinely produce affordable, high quality components.

Approach

The Titanium Matrix Composite Turbine Engine Components Consortium (TMCTECC) is a pre-competitive industry consortium consisting of Atlantic Research Corporation, 3M, Textron Systems, Pratt & Whitney, General Electric Aircraft Engines, and Howmet Corporation. The six member consortium is bound together by an agreement called the articles of collaboration which defines the relationship between the companies, intellectual property rights and more. The aim of this cost-shared program is to mature the TMC fabrication industry and deploy TMC's in advanced gas turbine engines. This work is being done in a manner that should assure the TMC supplier community is self sustaining without the need for government subsidy at program completion. This outcome will facilitate the ready availability of TMC material for a variety of defense and commercial applications without the need for long lead time industrial base maturation. The specific goal of this effort is to make this a stable and demonstrated "production ready" industry in time to significantly impact the Joint Strike Fighter (JSF). TMCTECC is in the second phase of a three-phased program. Phase I, "Feasibility Establishment," provided fabrication demonstrations and TMC process development. Phase II, "Production Capacity Establishment," is establishing a TMC production capacity and providing performance demonstration for specific components. TMCTECC will accomplish this by implementing TMC material into components requiring an annual volume sufficient to stabilize the industry. A manufacturing base capable of producing 15,000 pounds per year can readily support the relatively small volumes anticipated for use in all engines/applications in the foreseeable future. The specific Phase II program goal of an annual capacity above 2,500 pounds will be demonstrated, a volume more representative of the anticipated military engine requirement over the next several years. The first production application will be TMC nozzle links for the General Electric F110 engine. Over 2,000 links will be manufactured and deployed by the end of the program in December 2000.

Benefits

This program will develop a cost-effective industrial infrastructure for TMC's and the related gas turbine engine hardware. Significant weight savings is projected for JSF.

Status

Active
Start date: August 1994
End date: December 2000

Resources

Project Engineer:
Kevin Spitzer
AFRL/MLMP
(937) 904-4599

Title III Funded

Contractor:
Titanium Matrix Composite Turbine Engine Component Consortium

Index